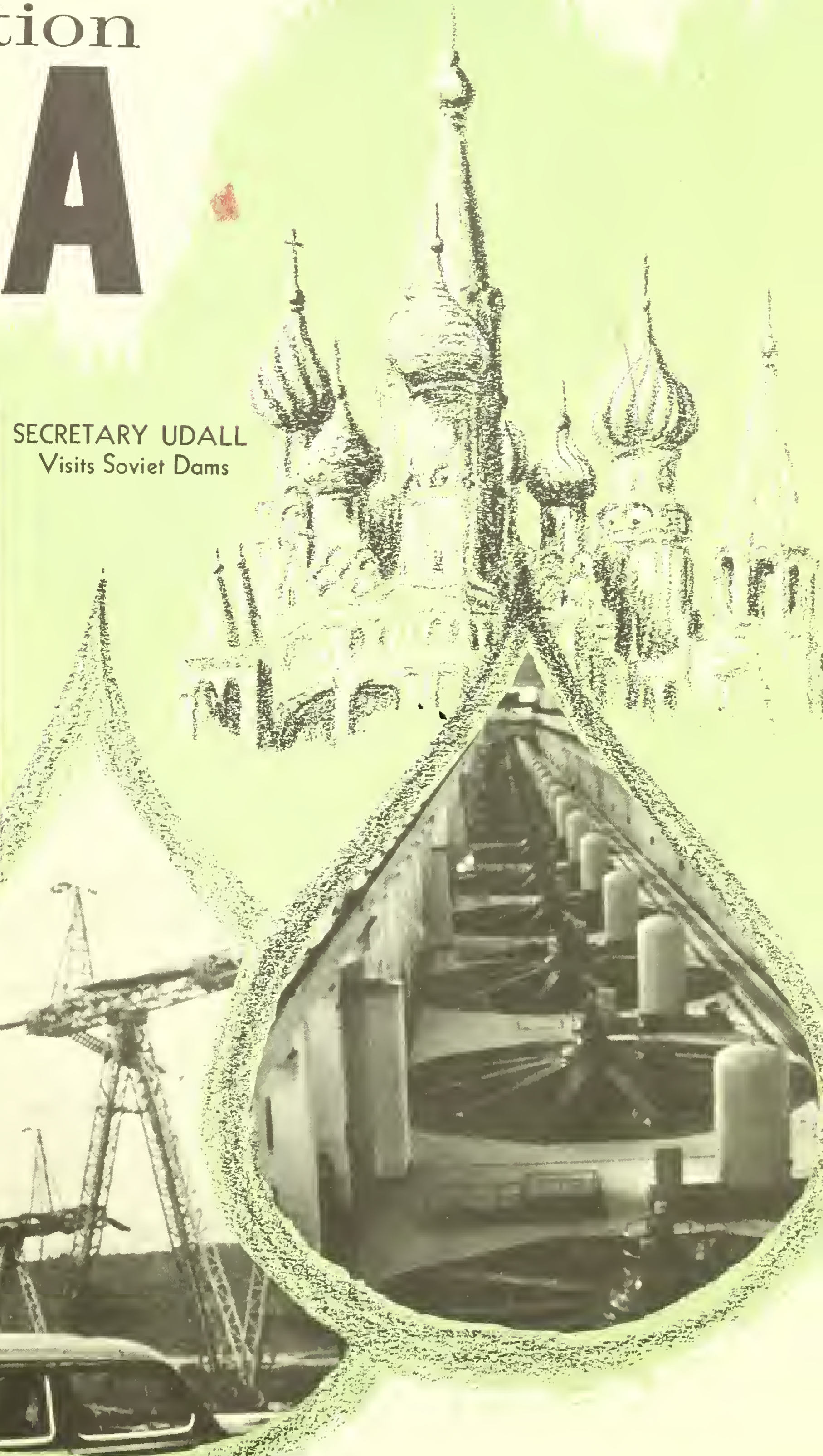
Reclamation ERA

SECRETARY UDALL
Visits Soviet Dams



FEBRUARY 1963

The Reclamation Era

FEBRUARY 1963 VOLUME 49, NO. 1

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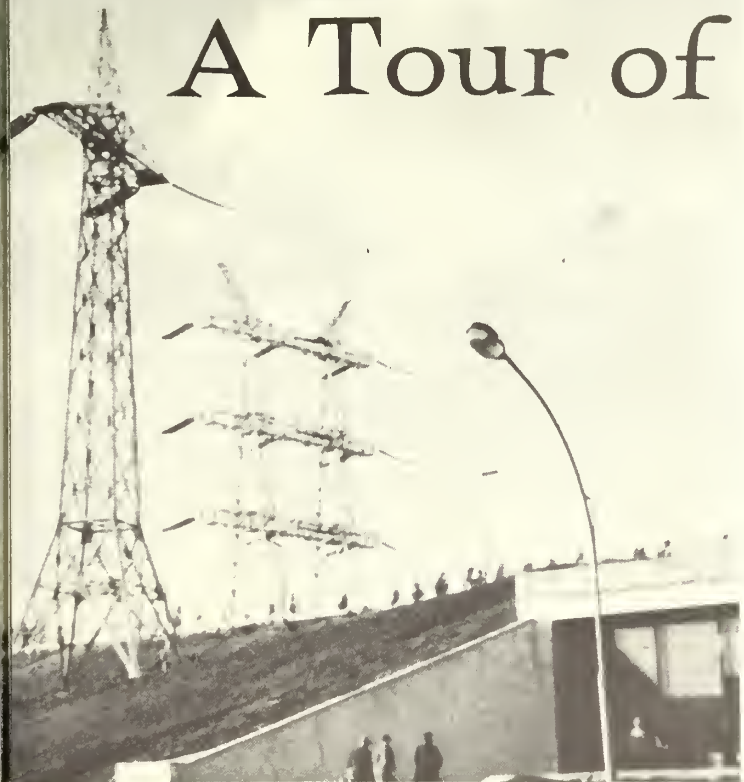
A Tour of SOVIET DAMS

Economic Risks in the World Energy Race

by STEWART L. UDALL,
Secretary, United States
Department of the Interior



Tower in foreground is part of a 800 kv. DC transmission line under construction at Volgograd Dam. Two 500 kv. AC lines in background. Entrance to power plant on right.

WHEN the Bureau of Reclamation completed Hoover Dam in 1936, it was the highest in the world, created the largest reservoir and boasted the largest hydroelectric plant. Its transmission lines carried power away at the highest voltage used anywhere in the world.

Today, Hoover ranks ninth among high dams of the world, 19th among hydro generating plants and Lake Mead, backed up behind Hoover Dam, is 15th in rank among all manmade lakes on projects either in operation or under construction.

Many of the projects which have outstripped Hoover in one way or another have been built by other countries, but we have not stood still, for many others are in this country. I am using it only to illustrate a point—there is no monopoly on knowledge.

Worldwide Technology

From the time Hoover was first designed and construction started, engineers from all over the world have beaten a path to it and to the design and research laboratories of the Bureau of Reclamation in Denver, Colo. Nevertheless, we would be absurdly blind if we ignored other world engineering developments.

Cascade of transformers for testing at 2,250 kv. at Moscow.

Central Dispatching Center in Moscow is being observed by members of Secretary Udall's group. Practically all of European Russia's power, 30 million kilowatts, is under unified control and is dispatched here.

The world of technology is undergoing a constant change and it behooves us to be alert, maintain our initiative and imagination. We must keep abreast of advances elsewhere and use our knowledge to the best advantage of our own country.

That is why I welcomed an opportunity to head a U.S. delegation to Russia in exchange for a visit by a group of their power executive and technical people to our country. Accompanying me were representatives of the Bureau of Reclamation, the Bonneville Power Administration, the Tennessee Valley Authority, the Federal Power Commission, and the Corps of Engineers.

In our limited time, we visited the Bratsk and Irkutsk dams in Siberia and Volgorad and Kuibyshev dams on the Volga River in Russia.

Engineering Achievement

We saw the operation of a high voltage 500-kilovolt alternating current transmission line and construction of an 800-kilovolt direct current transmission line which has since been placed in operation. We discussed the Russian water and power resource programs with representatives of the Russian Ministry of Power and with their engineers and scientists at the Moscow Institute where all the designs were prepared.

Their long-range plan is to interconnect all electric power throughout the Soviet Union—an area which consists of one-sixth of the earth's land mass. Considering that Russia covers 11 time zones and several climatic zones, this feat—if accomplished—will be a major engineering achievement.

Thus, in reality, the so-called energy race is basically one of technology—or, if you will, education, endurance, and cooperation. The Soviet Union has complete control of its resources, natural and human, which it can direct at will and without regard for the needs of individual citizens.

Harnessing Nature

The U.S.S.R. is a nation, remember, that already is planning to harness the tides and the sun, and plans to drill miles into the earth for new sources of power in addition to that produced by conventional means. It is a nation that is experimenting with automated ships and trains and is laying down a massive grid of fuel pipelines. It is a nation that only a few years ago ranked 21st in world trade, but today ranks sixth.

We have a formidable competitor.

Chairman Khrushchev has described electrification as the life breath of communism and the Soviet Academy of Science lists electrification of industry as their top goal, even above space exploration and missile development. The Minister

WHAT SECRETARY UDALL SAW IN THE U.S.S.R.

—*Bratsk plant* on the Angara River, already partially in operation, will have an ultimate capacity of 4½ million kilowatts—nearly 2½ times the capacity of Grand Coulee. Utilizing a 500-kilovolt transmission line, power will go to surrounding industry: iron and steel, lumber and aluminum. The aluminum works, incidentally, will produce—when completed—more tonnage than all of the aluminum plants in the Pacific Northwest combined.

—*Irkutsk Dam* is also on the Angara River and south of Bratsk Dam. Irkutsk Dam is a 8,989-foot earthfill structure with a hydroelectric capacity of 660,000 kilowatts of power. It does not have an overflow spillway. Bypassing water goes through 16 discharge sluices located between the generating units in the powerhouse. Lake Baikal is 385 miles long, more than twice the length of the proposed Lake Powell, and is reported to be the deepest lake in the world.

—*Kuibyshev plant* on the Volga River has a capacity of 2.3 million kilowatts, almost twice as much as Hoover Dam, and transmits electricity to Moscow and the Urals over a 500-kilovolt line.

—*Volgograd hydro plant* (formerly named Stalingrad) also on the Volga River, has a capacity of 2.5 million kilowatts and also furnishes power to Moscow over a 500-kilovolt line. This station is more than six times as large as the powerplant at Shasta Dam in California.

of Power has set the decade of 1970–80 as the time when they will reach, then overtake us in the energy race.

The Energy Race

This is a challenge which I have termed the energy race and it entails much more than mere generation and consumption of electric energy. It entails the ability of our Nation to maintain an economic system than can compete effectively not only with the Communist bloc countries but also with the reinvigorated economies of the Western world.

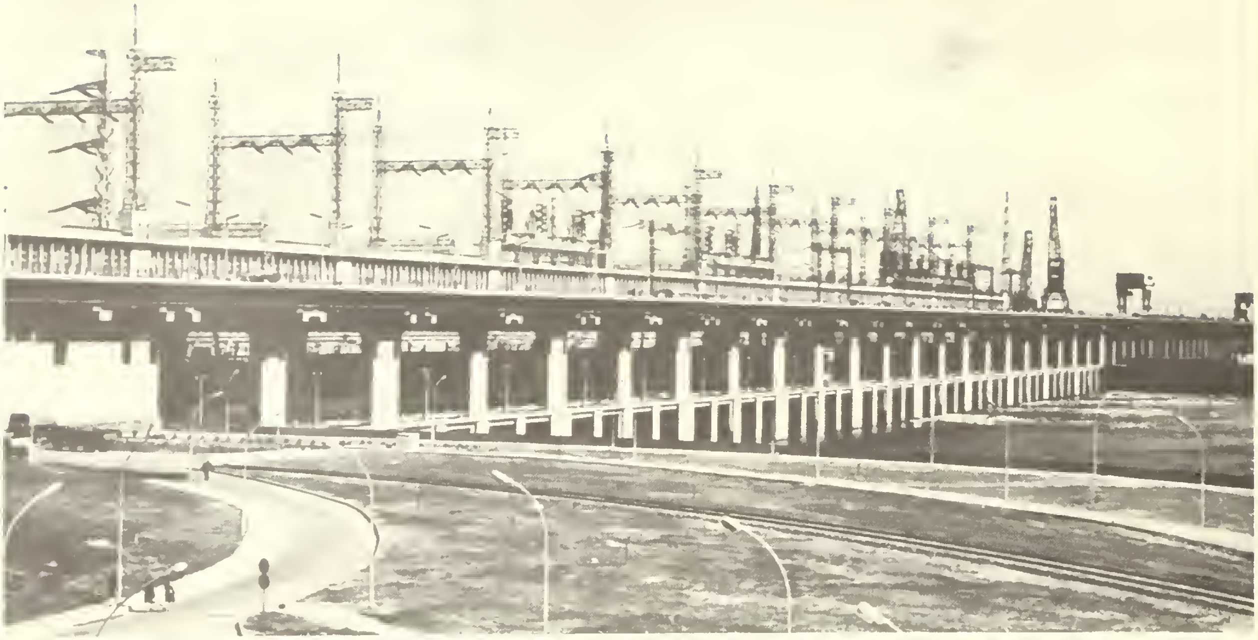
The growth and production of food and fiber for the Nation's industrial plant, for transportation, communications, and the many related daily activities requires energy. To maintain superiority requires the continued development of energy in all forms.

We cannot and we do not desire to win this race by adopting Soviet standards of living, labor, or government. But neither can we win it if we insist on erecting our own regional and economic barriers to each proposed forward-moving energy program.

I am not unduly concerned, for today we are ahead of the Soviet Union in nearly every phase of the energy race thanks to a tremendous head start. Our present superiority in electrical generation is nearly three times as great. Abundant, low-cost and widespread distribution of power is available through our land. After meeting all industrial needs, we still have enough to provide power for every conceivable use in nearly every home and farm in the country. Russia is funneling its power into industry on a command basis.

Construction underway on the downstream face of Bratsk Dam.

This woman is at work on construction of a dam.



Towers of the Volgorad Power Plant are shown against the sky. A railroad and a four lane highway crossing the 2½-mile dam are viewed on the showing side. Road in lower left leads to the power plant entrance.

United Spirit

We must maintain that superiority. This we can do by welding our aims in a unity of purpose but, also, with the continuing spirit of competition that has provided this Nation with unequaled human accomplishment.

We must take the calculated risks, both industry and government, in the challenging new areas before us, such as: rapid movement toward regional and national interties; extra-high voltage direct current transmission, and pumped-back storage. I am confident that the Federal Government, the public utilities, and the private utilities, aided by electrical equipment manufacturers, can compete cooperatively in this effort.

New Musts

We must move into new and unconventional methods of producing electrical energy. We must, for example, harness the tides, investigate more thoroughly the use of geothermal heat; expedite the development of fuel cells; start a program of solar research; and study some of the even more exotic ways of generating electricity.

We must put the interest of our people as a nation ahead of any particular group. When technological change will benefit the public interest, we can no longer—by politics, by lack of subsidy, or other means—hold it back through fear of short-term regional economic dislocation.

The leaders of government and leaders of industry in the United States have the same ultimate stockholders—180 million Americans. We are, in effect, the custodians of the future and what we do now and build now we are doing for the American people of the year 2000 and beyond.

# # #

(More pictures taken in Russia are found on page 26)

Another report of the United States delegation entitled "Recent Electric Power Developments in the U.S.S.R.," may be obtained by addressing your request to the Department of the Interior, Washington 25, D.C.

RECLAMATION Technical Leadership

Bureau of Reclamation engineers and scientists are constantly developing new and better ways to speed their work and to achieve greater economies on Reclamation projects. Their initiative and technical contributions are admired and emulated throughout the world.

Beginning in this issue of the Reclamation Era, *is the first of four articles describing some of the major technical innovations of Bureau engineers and scientists. The articles will highlight the impact of Reclamation's achievements on current work, and will also illuminate the Bureau's capacity to initiate water and land resource projects of the future.*

FLOYD E. DOMINY, Commissioner
Bureau of Reclamation

Part I—COMPUTERS WORK IN RECLAMATION

THE BUREAU'S westwide operations move swiftly forward with the aid of electronic computers. The amazing speed and accuracy f the machines is important in solving a wide ariety of complex engineering and scientific probems in minutes or even seconds. This contrasts harply with the many weeks or months which vould otherwise be required of engineers using esk calculators.

Thanks to the pioneer work of Reclamation engineers in applying electronic computers to water nd land resources problems, the high-speed mahines save the Bureau money and time.

The first computer in the Reclamation Engieering Center in Denver was installed in 1952. t was one of the first such installations in the Rocky Mountain area, and it was readily put to se solving problems in the design of concrete lams, analyses of complicated hydrologic systems, esign and operation of high voltage electric power systems, and many other scientific investigaions.

In the years that followed, the original machine was replaced by a larger computer. It was used on an increasing variety of problems. This computer is now used as an aid to:

- design concrete and earth dams
- calculate earthwork quantities for canals, laterals, and roadways
- determine the amount of sediment carried by streams and rivers, and
- design powerplants and pumping plants.

Here are a few examples of the use of the computer in the Denver Center.

For Earthwork

. . . Bureau specialists have developed computer techniques to relieve canal designers of computing earthwork quantities for canals and laterals. With this rapid method they calculated earthwork for more than 1,100 miles of canals and laterals resulting in a saving of 57 man years of engineering talent. This is the equivalent of $350,000 savings over conventional computations.

. . . Where and how many new transmission lines would be needed to deliver electric power from powerplants to load areas? This was a question in the analysis of an electrical system for the five-State loop of North and South Dakota, Nebraska, Iowa, and Minnesota. The system entailed 5,000 miles of high-voltage transmission lines and 35 powerplants. Simultaneously solving 60 complex equations, the electronic computer gave the answer to the power flow problem in 60 minutes. By comparison, an engineer using a desk calculator would have required about 2 years to solve it.

Dam Performance

. . . To keep track of performance of completed dams, Reclamation engineers embed instruments in earth and mass concrete at the time of construction. At Hungry Horse Dam in Montana, for example, 700 instruments were embedded in its more than 3 million cubic yards of concrete. Some 15,000 instrument readings have been made since completion of the dam in 1953. Using a desk calculator, an engineer would have required about 50 years to solve the estimated 5 million arithmetical calculations that were needed. The electronic computer came up with the essential performance data in about 30 minutes.

. . . The computer makes possible accurate solutions to difficult design problems. This, in turn, relieves highly-trained engineers of the task of making routine and repetitive manual calculations, and allows them more time to devote to creative problems.

The Denver computer is being used two 8-hour shifts a day to process the large volume of calculations required in the Bureau's studies. In addition, the Bureau is also using a large computer recently installed in the National Bureau of Standards Laboratories at Boulder, Colo.

An engineer at the console of the high-speed electric computer at Denver, Colo.

River Systems

With the new computer at Boulder, Reclamation engineers are able to study the extremely complex problems of river systems. In analyzing the potential development of the Maxwell project in Arizona, basic data totaling 400 technical items were fed into the computer. In 10 minutes, the instrument gave pinpointed answers on potential yield of the proposed Maxwell Reservoir, power production in the area, and the other essential information. Using a desk calculator, an engineer would have needed a year to derive similar conclusions.

To assure that new problems of Reclamation engineering will be solved quickly and accurately, a task force of five engineers in the Denver office recently conducted a survey of Bureau offices in the West to determine where high-speed computers could be used to advantage. Some 200 different problems in engineering and scientific areas were singled out for computer solution. They include the areas of project planning of river basins, irrigation operations, power system operations, construction, and research.

The work already completed by electronic computers and the future problems envisioned for computer solution are assurances to the public of the Bureau's preparedness to efficiently accomplish its mission of developing water and land resources.

# # #

The curving crest of the Hungry Horse Dam in Montana showing the "glory hole" type spillway at left.

Need better works?

a loan is available

There is a way to make irrigation systems efficient and to reduce the great wastes in our resources

SINCE the small project loan program got under way in 1957, there have been 26 projects approved for the use of over $67,000,000 in Federal funds. These projects have provided additional pumping plants or wells, reservoirs, new distribution systems to save costs of operating the systems, new water supply sources, groundwater replacement systems, groundwater recharge facilities, and projects to modernize the irrigation facilities.

Flood control grants and fish and wildlife grants have been developed, as have power benefits and provisions for muicipal water supply. Irrigation also has had an interesting variety of problems to solve. Even a 5-mile tunnel and other such works have been constructed to irrigate pineapple fields on Hawaiian homesteads.

In most respects, the small project loan program has been highly successful. However, few local organizations have utilized it to improve and modernize their facilities. This story of a mythical project that hasn't been proposed for the loan program is typical. It shows a serious need and a way to solve the problem.

Ample Water

Lavish Water District was formed about 1920 to take over the facilities of three financially distressed irrigation companies. The irrigation works were constructed between 1890 and 1910 and have been maintained in serviceable shape.

Although the main supply canals pass through sandy soils and are bordered by willows, Lavish District has ample water under its priority of being first on the river, and the water is applied liberally to the land. In a few areas, however, drainage problems are developing, and studies indicate that eventually the problems will be serious.

by **WILLIAM D. ROMIG,**
Engineer in the Division of Project Development, Washington, D.C.

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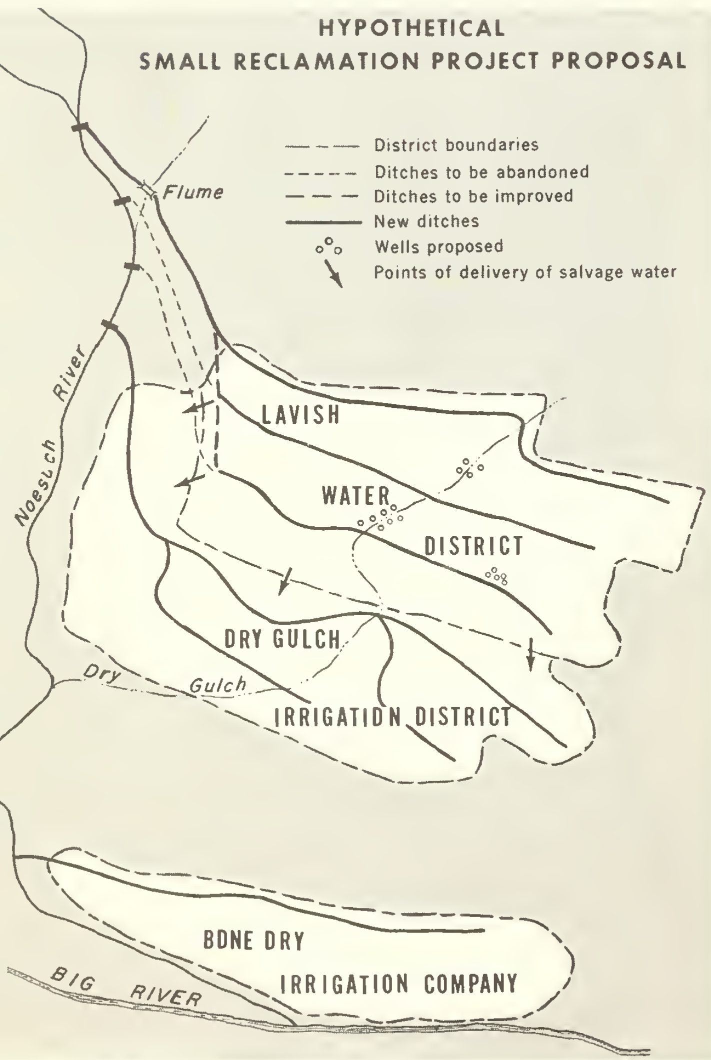
All irrigable land in the District is receiving water. Little seepage from the canals or operational waste are returned to the river but are consumed by nonbeneficial vegetation or by evaporation in sinkholes.

Occasionally Short

Immediately downstream is the Dry Gulch Irrigation District, also formed about 1920 to bring irrigation water to lands adjacent to the Lavish District. Dry Gulch District water rights provide sufficient water with careful use in most years. The management of this District has lined most of the ditches and they control the water efficiently so that with less than half the divertable water of its neighbor, it is irrigating about the same acreage.



The area is devoted to small tracts, intensively farmed. If Dry Gulch had the use of more water, it could serve additional acreages and reduce the occasional shortages.

Too Dry

About 10 miles downstream is the Bone Dry Irrigation Co., a mutual company formed recently by a group of farmers and ranchers having junior water rights, in an effort to develop a satisfactory irrigation system.

Water is available to Bone Dry Co. only in the spring and occasionally later in the season when not required upstream. For this reason the area is devoted to livestock, and irrigation is limited to native hay and pasture. The soils, however, are excellent. Within the area served by this company there are a number of large ranches, so that about one-third of the land is in excess of 160 acres in a single ownership. It is anticipated that most of these would gradually be subdivided, if general cropping were practical.

Old System

These three organizations represent all of the water users along this tributary stream, and they utilize all of the useful water supply. Except during periods of flood, no water flows from this tributary to the main stream below and no water rights downstream have a claim to water ahead of the latest right of these organizations.

The management of the Lavish Water District realizes that the old systems are wasteful and that its operation, maintenance, and replacements costs could be reduced by modernization. Could the savings justify the expense of Lavish District making these improvements? Could the waste water be salvaged and have sufficient value to justify a system that would be efficient?

Since there is no need for salvaged water within Lavish District, it would go to the downstream junior water rights. This has not been sufficient incentive to improve the system, and it would only increase the water charges to the farmers with no benefits to them.

More efficient use of water, however, would be of material benefit to the two needful areas and would be highly desirable from the standpoint of all three water organizations.

Loan Proposal

A loan could be proposed by the Lavish Water District, to be financed under the Small Reclamation Projects Act of 1956. The loan would be for the rehabilitation and betterment of its system, to enlarge and line the uppermost of its existing three supply canals, and to abandon the other two.

It would line the larger ditches and convert most of the distribution system to pipelines. Adequate measuring equipment and wells would be installed to drain the areas with growing drainage problems.

The financial arrangements of these developments are interesting. The project will save about half of the water now being diverted by Lavish District. From other savings in the costs of operation, maintenance and replacement and from the value of the drainage, it will be able to repay about 35 percent of the loan.

About a third of this salvage water will be sold to Dry Gulch District, delivered at several points along the common boundary of the two Districts. This will permit irrigation on lands above the present facilities of Dry Gulch District and will eliminate all of the water shortages now experienced in the rest of the area. For this water, Lavish District will receive sufficient income to pay about 25 percent of the loan.

A formal agreement between the two Districts will be required before funds are advanced for the loan.

All Around Benefits

Bone Dry Co. would enter into an agreement to pay for all water released by Lavish District which reaches the lower District on a per acre-foot basis. This represents two-thirds of the salvage water of Lavish District minus channel losses and will be sufficient to permit production of general crops on most lands served.

For this water, Bone Dry Co. will pay enough to permit Lavish District to repay the remaining 40 percent of the loan. It will also pay interest charges that result from the excess lands within its boundaries, as they exist each year.

The small project loan, when approved, will be to the Lavish Water District, which will be responsible for its repayment. This District, in turn, will arrange payments from the other two Districts.

A loan is in process for rehabilitating this canal in Utah. L. E. Blanch, left, H. E. Nielsen, right.

Improved System

Thus through cooperation, the applying District will improve its system and reduce its operating costs, a neighboring District will expand its acreage and reduce its water shortage, and downstream users will be able to improve their entire form of agriculture. More water will not be made available, but the existing supply will be more efficiently utilized.

No one will be deprived of needed water, and others will receive water now wasted. Also, Bone Dry Co. can apply for a small project loan to improve and expand its irrigation system.

Practical Combination

Although the foregoing small project is hypothetical, it is not impractical. Actually, most of the elements of this plan have been approved in actual project proposals.

We believe that joint projects such as this, offer important opportunities. Inefficient irrigation systems and water waste are incompatible with the optimum development of our resources.

Water users with old rights and old systems may not be expected to modernize their systems just for the benefit of the other water users. But the results can be, and should be, satisfactorily accomplished through joint efforts.

# # #

by K. FRITZ SCHUMACHER, whose primary position is as a hydraulic engineer with the Water Resources Division, U.S. Geological Survey, Los Angeles; also authored "The Fiery Ordeal of San Dimas," in February 1962, RECLAMATION ERA.

The Desert Almost Drowned

THE Imperial Valley of Southern California is the result of a series of geologic and climatic excesses tempered by man. At 500-year intervals a desert oven became a vast inland sea, an evaporating-pan for part of the generous discharge of the Colorado River.

The adjustment of these violent extremes permitted the development of a large and prosperous area of reclaimed land. This accomplishment involved a battle with forces of nature never before encountered on a similar scale.

In 1905 the river broke loose, determined to drown the former desert and all man-made improvements. At that time, it took the frantic efforts of the local people and the equipment and manpower of a railroad to save the area from a watery grave.

Thirty years later the completion of Hoover Dam by the Bureau of Reclamation tamed the river. But the story here deals with the Colorado when it was free to follow its own devastating whims.

Millions of years ago the Gulf of California extended northward into San Joaquin Valley. Folding of the earth's crust raised the mountains along San Gorgonio Pass and dropped the bottom of Salton Sink several hundred feet below sea level. The mighty Colorado continued cutting its Grand Canyon through other upthrust mountains to the northeast.

Eroded material deposited in the Gulf in a fan-shaped delta gave Imperial Valley its 2,000-foot-deep layer of rich alluvial soil. When the delta reached across the Gulf, Salton Sink became an isolated inland sea. The river continued to meander back and forth across the delta. Over countless ages it built a 300-foot-high dam, ranging in width from 140 miles at the base to 60 miles at sea level and 10 miles at its crest 35 feet above maximum Gulf tide.

Perfectly Safe

This natural dam far exceeds in volume any earthwork ever attempted by man. It forms an effective barrier against inundation from the sea, by seepage or otherwise, and it is perfectly safe to live in Imperial Valley, some 200 feet below sea level.

The meandering lower Colorado River had swept its delta from east to west every 500 years. The east slope drains into the Gulf, the west drained into the former Lake Cahuilla which at times covered all of Imperial and Coachella Valleys. Its shoreline is still visible at the base of Santa Rosa Mountains west of Salton Sea, at altitude 30 feet above sea level.

Marine deposits and shells along this shoreline left a fairly accurate record of periodic inundations. At the depth of a dry cycle in 1849, the possibilities were recognized of irrigation from the river which alternately drowned and deserted the area.

Reclamation was undertaken at the close of the century by California Development Co. The first water reached Imperial Valley in May 1901. The company operated on both sides of the inter-

Railroad tracks of the Southern Pacific were washed out as shown in this photo taken September 1, 1906, a few miles southeast of Calexico, Calif.

ational boundary. A headgate was installed on he Colorado River 1 mile within the United States. Thence a canal carried the water to Alamo River, a former distributary channel in Mexico.

Pioneer settlers reaped the benefits of a natural othouse. Grapes, melons, and garden vegetables natured earlier than elsewhere. Grain and long-staple cotton thrived. Alfalfa yielded at least ive cuttings per year.

For several years, the river yielded generously ts life-giving water with suspended silt thrown in, gratis. Gently sloping canals and the weed-hoked Alamo River invited deposition of silt aster than it was dredged out. Several dry years nade transmission of enough water through silted vaterways extremely difficult. When crops began o wilt, the company decided to take a calculated isk.

River discharge records for the past 27 years ndicated only three winter floods and not more han one per year. So in 1905, the river bank was ut south of the border. At once more water lowed down Alamo River, sluiced out canals, and aved crops. In spite of misgivings voiced by an ngineer, installation of control gates had to wait.

The temptation thus placed before the Colorado o end a quarter century of good behavior was too great. An unprecedented series of fall and winter loods widened and deepened the cut beyond possi-bility of control by the proposed headworks. The anal system was sluiced out with a vengeance. The west slope of the delta was laid down in the still water of Lake Cahuilla.

While townspeople frantically threw up dikes against an overland sheet of water pouring in from Mexico, a cataract—formed near the Salton Sea mouth of the revived Alamo River—advanced up-stream at the rate of 1 mile per day and threatened destruction from the rear. In desperation, the gorging process was hastened with dynamite along a course a safe distance from the town of Brawley. The New and Alamo Rivers moved more than four times the total Panama Canal excavation out of their 50- to 80-foot-deep gorges during their 2-year rampage. On the credit side of the disaster, these gorges later formed the main stems of a much needed drainage system.

California Development Co. exhausted its re-sources in several futile attempts to close the Mexican diversion, which soon turned the entire flood-swollen Colorado River into Salton Sea. It was forced to borrow men, money, equipment,

Rising Salton Sea put limits on travel. (Southern Pacific photo)

Crewmen tumbled rocks off flat cars to dam the rampaging waters. (Southern Pacific photo)

and consulting services from the Southern Pacific Railroad; but all the effort was to no avail.

Ugly rumors of criminal negligence were heard. It soon became aparent, however, that more than an error of judgment was involved. The river's 500-year cycle of discharge into the Gulf was drawing to a close. The constantly meandering river was due to resume its periodic drowning of the desert. Could mere man attempt to readjust this relentless cycle?

President E. H. Harriman of the Southern Pacific asked his chief engineer this question. The answer was "yes." The railroad assumed the liabilities of the defunct development company including the job of taming the river. Harry Cory became resident engineer, but for over a year there was no time to "reside."

Headgate Constructed

Construction of a new concrete headgate in the United States was undertaken. A bypass and temporary wooden gate in Mexico proceeded simultaneously with the closing of the break that had become a half-mile wide. A timber trestle on 90-foot piles was built across the gap. Six tribes of Indians wove 13,000 square feet of brush mat which was lowered to the bottom. Rock from Pilot Knob nearby was dumped onto the mat to prevent sinking into the bottomless silt. All went well until the only opening left was the timber gate. An attempt to reinforce the sagging structure with rock resulted in washout of trestle and rock cars. The floating debris dislodged the gate. It went west with the river—into Imperial Valley.

The battle was resumed immediately, without benefit of gate or brush mat. Pilot Knob quarries proved inadequate and rock trains reached deep into California and Arizona for U.S. real estate to dump into the Colorado River. The gap was closed in 3 weeks. On November 4, 1906, the river resentfully returned to its proper channel. But it continued to probe for weak spots in its west bank.

A month later, it found one in an earth levee. In flood-swollen defiance, approaching 100,000 cubic feet per second, the river once more threatened the Valley. This time hope grew dim. The railroad was ready to give up the battle of the delta. It became necessary to concentrate effort on a sixth and final move of trackage out of Salton Sea.

Stop the River

Mr. Harriman made a personal inspection and issued the fateful order: "Stop the river at all cost."

Rock trains rolled nearly 500 miles into Colorado and New Mexico. They were given right-of-way over all trains on 1,200 miles of Southern Pacific main lines. Two parallel trestles were built across the break. The first one reached across after three washouts. One thousand loaded rock cars were ready at the site to dump continuously. Men swarmed over flat-car loads of rock, like ants, to crow-bar them over the side. Pot shots of dynamite reduced boulders to manageable size.

Trains of "battleship" side-dump cars deposited finer material to seal the rock dam. After 15 days and nights and 80,000 cubic yards of rock, the river was finally subdued. Then, 9 more miles of rock rip-rap were needed to reinforce unreliable earth levees.

Imperial Irrigation District was organized in 1911. It acquired water works of the former development company from Southern Pacific in 1916.

When Hoover Dam was completed by the Bureau of Reclamation in 1935, the desert-drowning cycle of the mighty Colorado River was finally controlled.

# # #

helicopter delivers HERBICIDE AIDS

FACED with the problem of an invasion of noxious weeds in an area too rough for trucks and too near newly developed farms on the Columbia Basin Project for conventional airplane spraying, Del Suggs, the Project's Management Agronomist, came up with a novel and efficient solution.

Through the use of a specially designed spreader attached to saddle tanks on a standard Hiller 12E helicopter, about 8 tons of the herbicide Borate-TBA were applied in 6 hours last June to some 80 acres of weed infested land adjacent to the project farms.

Excellent Kill

Early fall examination of the area revealed an excellent kill of weeds on moist soil where the new granular herbicide had been absorbed into the soil. Granules were still present on dry soil but winter rains are expected to carry the chemical into the ground.

"These steep walled valleys, or coulees, provide a seeding ground for such noxious weeds as morning glory, Canada thistle, Russian knapweed, and other weed pests," Suggs said.

Timing Application

Suggs also pointed out that the timing of the application of chemicals used to be of prime importance because many herbicides deteriorate when exposed to direct sunlight before they can be absorbed into the soil and do their job on the weeds' roots. However, the new granular herbicides, such as Borate-TBA, are not sensitive to sunlight. This makes these chemicals particularly suited to aerial application, which is better done in fair than foul weather.

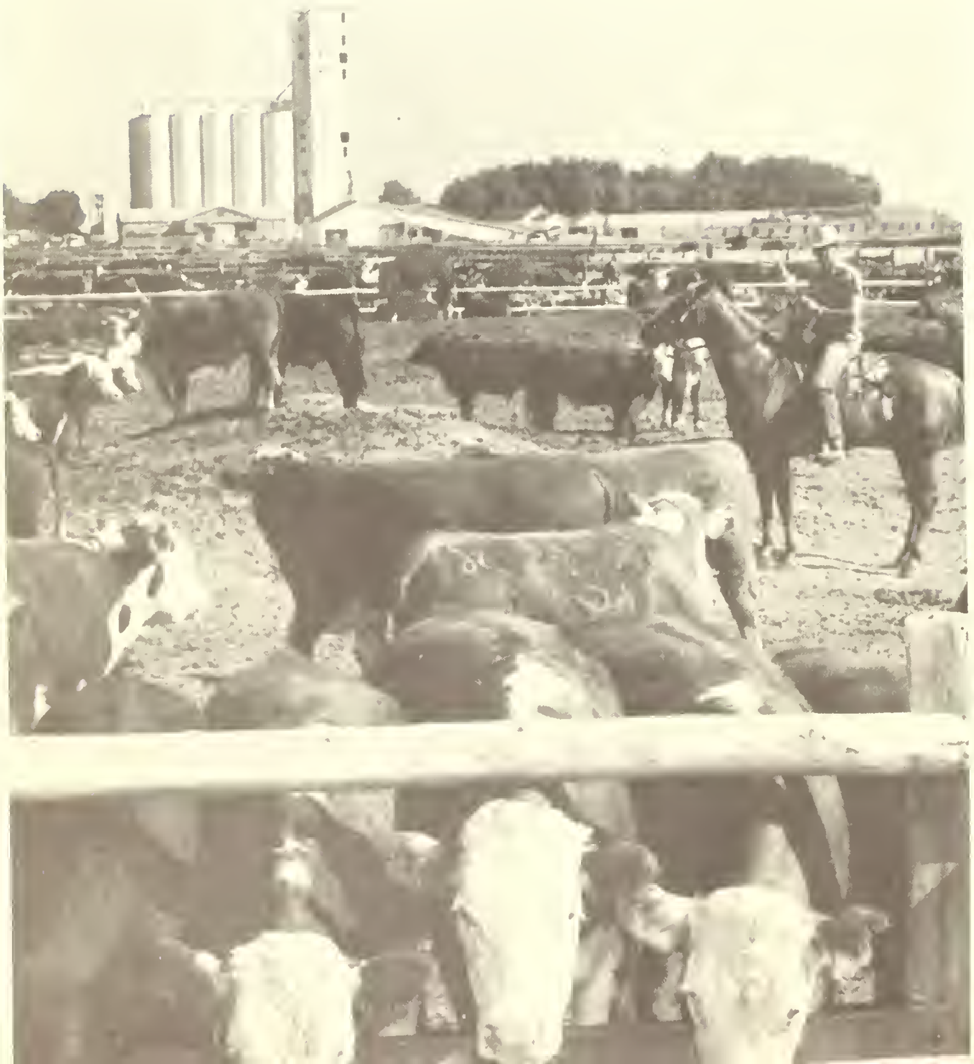
As more and more land comes under irrigation and more diversified crops are grown, the problem of weed control on noncroplands adjacent to hormone sensitive crops become more complex. Although hormone weed control sprays are now used effectively by ground crews, rough terrain makes this a time consuming and sometimes impossible chore.

Also the problem of drift has virtually eliminated aircraft application of chemical weed killers near sensitive crops. All of which adds up to the fact that the whirlybird with a payload of granular herbicide may become a familiar sight in project skies in the future. # # #

In honor of the 25th Anniversary of authorization of the Colorado-Big Thompson Project, which was celebrated last December, the *Reclamation Era* is publishing Mr. Price's interesting article. The project was found feasible by the Secretary of the Interior on December 20, 1937, and it was approved by the President on the following day, December 21.

A Colorado farm

100 YEARS o



Left. Feed lot of K. W. Monfort in the Color

Below: Mr. and Mrs. Lloyd Dickens of Lo
was built more than 100 years ago.

ATTLE FEEDING

by WILLIAM A. PRICE, Chief,
Land Use and Development Branch,
Irrigation Division,
Denver, Colorado

project area.

d in front of their home which
igation and raising cattle.

SOMEONE has said that half the world's population goes to bed hungry every night. It could be a complicated job, undoubtedly, feeding all the people in the world. But a lot of good beef is produced in northeastern Colorado that helps to fill the stomachs of part of the world's population.

Irrigation on the Bureau's Colorado-Big Thompson project has helped make this area a well-known producer of most forage products needed for raising high quality beef.

In 1962, approximately 700 million pounds of market beef were sold from the Colorado-Big Thompson project area, with intensive feeding accounting for 245 million pounds of grain.

In 1961, more than 700,000 beef animals were fattened for market in the area comprising the Northern Colorado Water Conservancy District. This District has contracted with the Bureau of Reclamation to repay part of the construction costs of the project and receives supplemental irregation water supplies from the Colorado-Big Thompson project facilities.

The average gain placed on these animals while in the feed lots was about 350 pounds per animal. Thus, due to feeding facilities in this project area, an additional 245 million pounds of live, finished beef were produced for market from the 700,000 cattle fed.

Feeding operations in northern Colorado have changed in the past 15 years. Small feeders have become fewer and they each fatten about 50 head of beef for market each year. Large commercial feed lots feeding the year around have entered the picture.

At least one commercial feeder prepares about 100,000 head for market each year; several others market from 20,000 to 35,000 head annually.

Pioneer Dickens

More than 100 years ago, a hardy pioneer, W. H. Dickens, began diverting water from the St. Vrain River and producing feed crops and livestock. He watered a homestead which he had staked out in the St. Vrain Valley near Longmont, Colo.

That was in 1859, and was the start of the Dickens feeding business. Then in 1862, a water right was issued to the W. H. Dickens irrigation company, the Beckwith and Niwot Ditches.

This irrigated Dickens farm is now run by the original owner's grandson, Lloyd Dickens, and it is typical of the farmer-operated feeding business.

In 1962, Lloyd Dickens fed about 1,000 head of cattle for market on this 440-acre farm, of which 370 acres are still irrigated with water from the St. Vrain River.

In the 1950's, Lloyd's condition was different. He discovered that his farm was too small to give a worthwhile return on the huge investment required in land, livestock, and equipment. Also, he decided not to purchase additional land, but to intensify his operations by increasing the number of cattle fed each year. This started his successful feed lot business.

(*Continued on page 25*)

Irrigated pastures and grain fields are produced. Below. Frank Neville with his Angus bulls.

Power from...

a spare on wheels

This mobile substation was put to use in the enclosure of the Whately Substation, Fort Peck, Mont.

To bring the magic of electricity to people in the Great Plains is a responsible job, and mobile power units have proven to be the answer in the rare but inevitable emergencies.

At 4:40 o'clock one morning in 1960, South Dakota's capital city of Pierre, the nearby town of Fort Pierre, and farmers in those parts, suddenly were without electricity. The main power transformer had gone out at the Pierre Substation.

The people ate cold meals, dairymen milked their cows by hand instead of with machines, and hundreds of schedules and customary services had to be changed until power could be returned.

A mobile "spare on wheels" power unit was immediately summoned for this emergency to the people in the center of the State.

Investigations proved that a power transformer at the Pierre Substation was seriously crippled and possibly would be weeks or months being repaired. Remaining power from the substation was capable only of supplying service to part of the city of Pierre, a small emergency connection to Fort Pierre's water pumps, and a few priority loads. Both cities experienced a lack of police and fire warning call systems, and hospitals were on their own emergency power facilities.

Rural consumers went on rotation schedules of alternating power service from one section of farmers to another.

The emergency unit needed for this critical situation affecting more than 12,000 people, was the large three-phase mobile substation which was stored in readiness at Watertown near the Minnesota State line. The Bureau immediately brought the unit and set it up by the Pierre Substation. It was soon operating and supplied all requirements of the two cities, as well as the Oahe Electric Cooperative, thereby avoiding a prolonged emergency for the residents.

Willing Service

Although the vast Great Plains territory is dotted with towns, farms, factories, and its share of large cities, every effort is made to achieve 100 percent continuity of electrical service. And, in spite of a rigid inspection program and advance precautions, outages similar to the one in central South Dakota occur.

The Bureau of Reclamation has constructed about 4,700 miles of transmission line that inter-

connects with 89 major load centers in the eastern division of the Missouri River Basin power system. This is part of a tremendous network of generating and transmission facilities now serving nearly 164 wholesale preference customer organizations such as rural electric cooperatives and municipalities who in turn, through their facilities, bring electricity to the people.

Interruptions of regular power service are attributed to mechanical malfunctions, and general emergencies such as floods, fire, storms, and other disasters. When a permanent power substation goes out, no matter how isolated its location, the objective is to restore it as fast and economically as possible.

What They Do

In the MRB eastern division, are six mobile units. This emergency fleet is permanently mounted on individual semitrailers. Although they are very heavy, they usually travel on their own rubber tires, but sometimes they are pulled for part of their trip on railroad flat cars.

The Bureau has two kinds of mobile power units. One, the substation, is a completely self-contained unit consisting of a transformer and its associated facilities. When failure occurs at a smaller installation, a complete mobile substation is generally used to plug the gap.

The other, a mobile transformer, is a heavier piece of equipment and is designed in most cases to deliver higher kva. output. For maximum benefit, they must be large enough to provide capacity voltages at major permanent substations.

Mobile power units have proven to be valuable power equipment not only in emergency use, but in problems of equipment change or repair.

Critical Situations

A 2,000-kva. mobile transformer which is stored at Jamestown Substation in North Dakota, was taken to the substation at Rolla in July 1962, to take over where a permanent 1,500-kva. transformer had failed leaving a rural electric organization without power. In this case, no alternate source was available and a long outage of electricity would have caused hardship for Bureau preference customers and their individual consumers.

At the time of this writing, the Bureau transformer is still providing complete power service at Rolla and is intended to continue until the damaged transformer is replaced.

Recently, the 115-kv., 5,000-kva. mobile substation was used for 6 weeks to supply power to the Oahe Electric Cooperative while the main power transformers were moved from the temporary substation to the Oahe Powerplant switchyard. The mobile unit in this case saved the expense of constructing temporary facilities to serve the load while the change was being made.

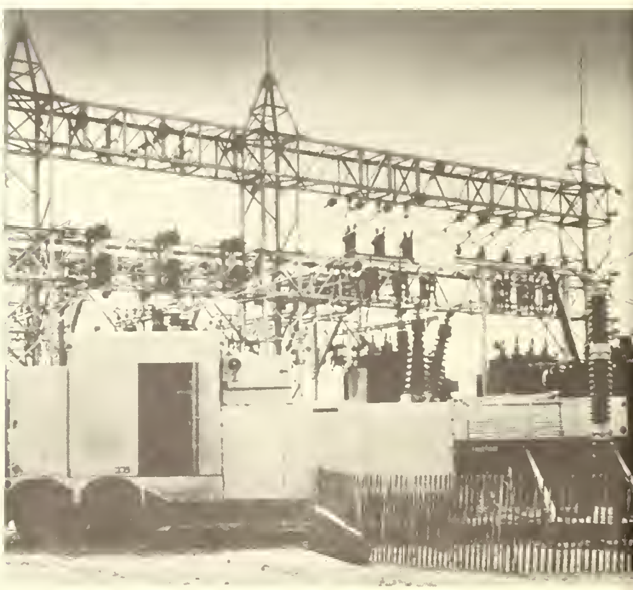
Lightning Damage

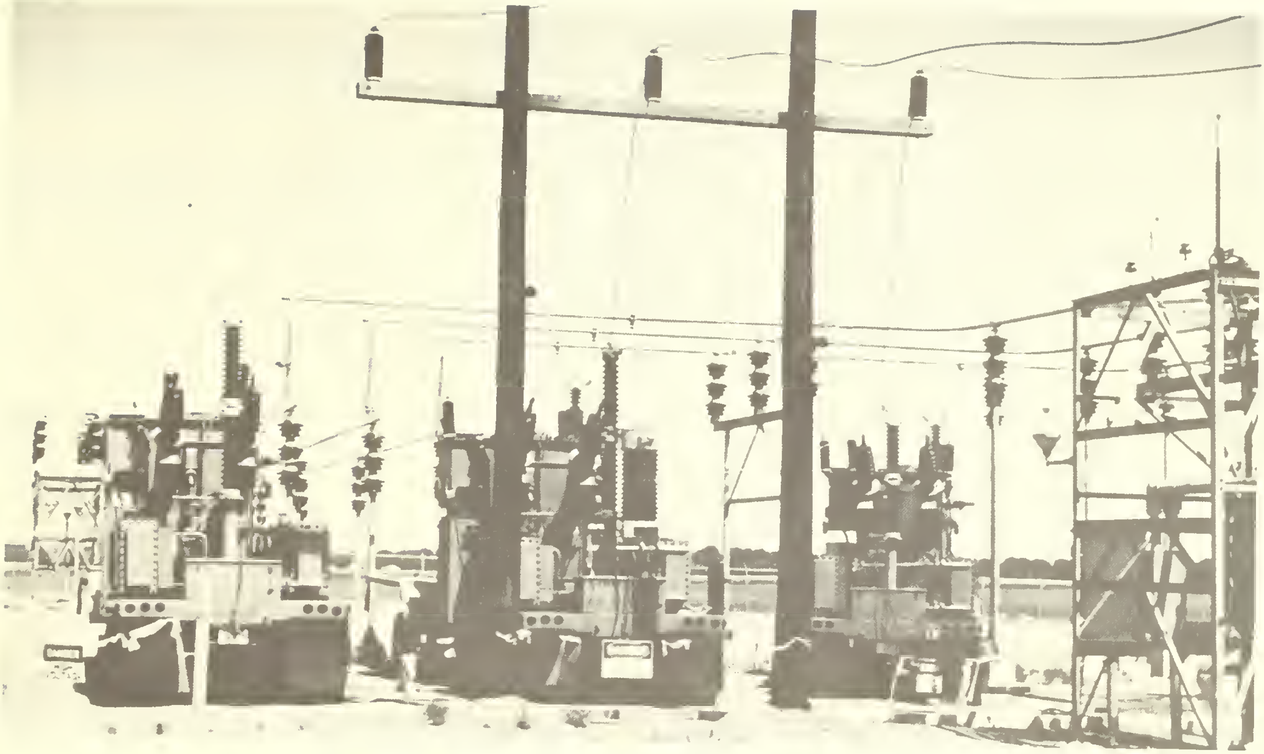
At Woonsocket substation in southeastern South Dakota, an emergency occurred when an apparent severe lightning discharge damaged an air break switch belonging to the East River Electric Cooperative and severe damage to the Bureau's transformer, circuit breaker and other substation equipment. Thousands of rural customers in the eastern part of the State who were being served by the 34.5-kv. line were without power.

Through a good neighbor practice from Central Electric and Gas Co., and Northwest Public Service Co., some temporary emergency assistance was given to East River.

At the outset of East River's trouble, the Bureau's three 5,000-kva. mobile transformers were dispatched to the scene and immediately installed.

A 5,000 kva. mobile substation in operation in South Dakota.





Three mobile transformers in action at Grand Forks, N. Dak.

These units filled in for 8 months supplying a full service to all Woonsocket customers while repairs were made at the factory on the damaged permanent equipment.

Unit Explodes

An explosion and fire severely damaged a 50,000-kva. transformer at the Grand Forks Substation, in North Dakota. Again the three 5,000-kva. mobile transformers restored power service in a short time. They remained in service for 11 months while the damaged transformer was sent away for factory repairs.

When none of the power spares are available in MRB it is necessary to go elsewhere to fill a gap left by an inoperative transformer. This happened at the Forman Substation in North Dakota and a 62,000-pound mobile spare was transported in from the Central Valley Project in California. Two flat cars were used for its rail shipment to the North Dakota location and a carload of timbers were laid on the ground and used as an unloading dock.

Because of recent load increases, larger transformers for many Bureau substations will be required during the next few years.

Three More

In keeping abreast with the growing and changing system, the Bureau is now purchasing three additional mobile units. Two of the units will be identical 10,000-kva. three-phase with a primary voltage of 115-kv., a secondary voltage of 69-kv. and a tertiary voltage of 13.2-kv.

A third unit will be a 33,333-kva., single-phase auto transformer with a primary voltage of 230-kv., a secondary voltage of 115-kv., and a tertiary voltage of 12.47-kv.

Just a few years ago, the mobile substation used at Forman, had a capacity of 5,000-kva. and weighed 62,000 pounds. The new 33,000-kva. spare to be put in service has six times the capacity of the Forman unit yet weighs only 75,000 pounds.

When the three new mobiles are available for use along with the present complement of six units, high economy in maintenance will be realized, system investment in spare transformer capacity will be kept to a minimum, greater safety to personnel can be provided and customer outage time can be kept to a lower minimum.

These nine units will continue to provide the efficient good neighbor service that has enhanced customer confidence and satisfaction in Reclamation's power spares on wheels. # # #

Southwest *new*

by HARVEY A. BRASHEARS,
Bureau Engineer, Head,
Project Design Section,
McCook, Nebraska

NOT MANY years ago, even in southwest Nebraska's warmer months, there was very little fishing by outdoor sportsmen in that area. Now, however, there are many anglers, and anxiously, they try their luck in spring, summer, fall, and even in the dead of winter.

As early as March 1, 1955, when Swanson Lake first opened for fishing, a few hardy souls fished through the frozen covering, and from boats when the weather warmed. Apparently, a "good word" is spreading, because each year more fishermen drop hooks beneath Swanson ice as well as in two other Bureau of Reclamation bodies of water in the area. They are Enders Reservoir and Harry Strunk Lake.

Swanson Lake was probably the area's pioneer for ice fishing. It is behind Trenton Dam and is located on Highway 34, 3 miles west of the Trenton, Nebr., city limits. Some of its winter weather has been unfavorable for ice fishing, but when the ice is right, it produces its share of satisfaction for anglers. Although the wind sometimes gets chilly, it is not unusual to see 75 to 100 ice fishermen pitting their prowess against finny citizens in the icy waters.

Game Fish Added

Management of the fishing potential of Swanson Lake is under the jurisdiction of the Nebras-

Leon Schroeder of Levant, Kans., trying his luck at Swanson Lake just below Trenton Dam.

Nebraska's

winter sport

Have you tried ICE FISHING on a frozen lake? Nebraska fishermen have.

Albert Williamson of Stratton, Nebr., figures his luck will be just as good as the others.

ka Game, Forestation and Parks Commission. They make periodic stockings of walleye, black bass, northern pike, yellow perch, and other species.

No special license other than a regular fishing permit is required and limits and regulations governing ice fishing are the same as for open water fishing with one exception. The ice fisherman can legally use as many as 15 hooks, with no more than 5 on a line while fishing any body of water or stream. The summer fisherman can use only two lines with two hooks on each line, when fishing lakes, ponds, and reservoirs.

Legal daily limits for these species are 6 walleye, 50 crappie, 10 black bass, 6 northern pike, 7 trout, 50 bullheads, with no limit on perch or carp.

Gear and Bait

Equipment needed by the cold weather craftsmen are relatively few. An ice chisel (spud), or an ice auger if the fisherman wants to really go first class; a skimmer, or rubber gloves to dip ice out of the holes; tipups (an apparatus with a signal which is triggered when a fish bites); jig sticks (short cane poles), or any kind of rod and reel; hooks; bobbers; a heavy line and bait of the anglers are the usual line of items.

Many kinds of bait are used, such as minnows, worms, jigs or ice flies, strips of fat meat, plugs and spinners. Strange as it may seem, fish eyes from a freshly caught fish are often real fish-getters, especially when fishing for yellow perch. Of course, the angler must first catch one before the fish eyes are available for bait.

The ice cover at Swanson Lake is thick enough to hold fishermen during about 60 days of a normal winter. So they watch the cycles of freezing and thawing as well as the days when the temperature ranges from zero to 30 degrees above. The ice must be hard and thick enough for anglers to cross it. Most Swanson fishing is done in water that is 25–40 feet deep.

They Are Hungry

It is hardly a secret with these hardy outdoorsmen anymore, that they best put in their 3 or 4 hours in the early to mid-morning periods. The fish are almost as hungry as in the spring, summer, or fall, but they are not quite as active in searching for food. The main thing for the fellow who wants to try his skill for the first time, is watch old man weather and be ready.

There have been a couple of winters of unstable weather resulting in unsafe ice on Swanson. Then, of course, they take their skills to the lakes further north. But I allow that they'll also keep their eye on the lake closer to home, and too, be ready for good weather. Or is it bad weather?

Well, anyway, bet I haven't caught my last dinner through a hole in the ice at Swanson.

# # #

The city of Lethbridge is the irrigation capital of Alberta, Canada, and is located just 50 miles north of Montana. Oldman River shown near top. Story on next page.

IRRIGATION *PAYS* on Canadian Prairies

Editor's note: *Last summer a group of Reclamation specialists was assigned to study drainage characteristics of soils deposited by glacial action in the Province of Alberta, Canada. Incident to this assignment, they saw the interesting irrigation developments in southern Alberta. Two members of the unit prepared this illuminating article about a successful irrigation system that is similar to our own, yet different in some important aspects.*

by J. KARL LEE, Chief, Economics Branch, Division of Project Development, and

MAURICE N. LANGLEY, Assistant Chief, Division of Irrigation and Land Use, Bureau of Reclamation

ALBERTA has a million-acre irrigated "green belt" stretching across the southern part of the Province which is the backbone of prairie agriculture. This belt provides diversification of agricultural production and contributes to the stability of both the farm and nonfarm income for this Canadian Province located at the northern border of Montana.

The city of Lethbridge is the irrigation capital of this productive area, and it has a population of 36,000 people. Lethbridge is the supply center for the irrigated belt and is located about 50 miles north of the U.S. border.

Early irrigation development in Alberta was promoted by railroad companies. Progress in recent years, however, involves cooperation of Federal and Provincial Governments, as well as the individual settler.

Irrigation is being carried out under the provisions of Provincial Legislation as the Water Rights are vested in the Province. Alberta determines the conditions under which water shall be used, and grants permission for its use.

Initially, water was used by direct diversion of natural streamflow. However, it became obvious that streams, particularly in dry cycles, were inadequate; and, consequently, Canadians turned to storage.

The Federal Government constructs water supply facilities, and the Province constructs laterals, supervises the selection of settlers, and develops project lands. Individual settlers are responsible for development of the farm unit, although credit and technical assistance are made available by the Province.

Settlers are selected carefully and are required to pay, over a 10-year period at 3½ percent interest, only $10 per acre for a water right. Construction costs in excess of the $10 per acre are nonreimbursable and, in effect, are paid by the taxpaying public. A settler must also pay a nominal cost for the land. Where public lands are involved, he may pay over a relatively long period of time at low interest rates.

Acting through a special corporation, the Province operates and maintains the project facilities. For most projects, the annual operating costs run in the neighborhood of $2.00 to $2.50 per acre. The payment entitles the settler to a base allotment of approximately 18 acre-inches per acre.

Projects supplied with water from Federal Government works pay a water service fee of 25 cents per acre-foot to cover operating costs of the supply works. The water user is in turn assessed the full fee to cover all operating costs of both the supply works and distribution system. When available, additional water is secured by payment of the fee

Irrigating beans by spray near Cooldale, Alberta.

for acreages irrigated in excess of the classified irrigable acreage.

Basic water allotments are substantially less than the amount normally used in the United States, probably resulting from a somewhat shorter growing season, lower average summer temperatures, and more effective precipitation.

The most intensively irrigated area in Alberta is at Taber, about 30 miles east of Lethbridge. In this area, quantities of sugar beets, potatoes, dry field peas, dry beans, and various kinds of produce are grown for the fresh market and for canning and freezing.

Taber Industries

Taber also has a sugar-beet factory, several vegetable processing plants, and extensive livestock feeding enterprises. These feeding operations utilize alfalfa hay, small grains, and corn silage in addition to byproducts from the sugar beet and vegetable industries. Sugar-beet production in the vicinity of Taber averages about 14 tons per acre.

Typical crop yields per acre in the Lethbridge-Taber area are: oats—70 bushels, barley—50 bushels, spring wheat—45 bushels, soft wheat—60 bushels, seed peas—1,800 pounds, and alfalfa hay—2.5 to 4 tons. The potential yields as produced by near optimum management are from 20 to 50 percent greater.

The average annual precipitation at the city of Lethbridge is about 16 inches, of which about 12 inches occur during the growing season. Even though the growing season is shorter, the irrigated lands are adapted to a wide variety of crops. Crop production is successful because the more northern latitude causes the sun to shine longer each day; and this, combined with the elevation of around 3,000 feet, results in moderate temperatures.

Alberta farmers are encountering the same problems in irrigation as those in the United States. Most serious of these are seepage from canals and drainage problems. However, Canada has an extensive research program aimed at controlling seepage and reclaiming alkali and seeped lands.

Many land and water resources remain to be developed in the Province, and Canadian specialists are busily engaged in doing something about it. Currently under construction, for instance, is the Waterton River Dam, which will provide water for 150,000 acres of land.

In the United States, typical irrigation cities are often pointed to with pride. In Alberta, the city of Lethbridge is an example of the fruits of irrigation. Canadians have every reason to be proud of their accomplishments and of the prospering prairie communities that have sprung up in their "green belt." # # #

St. Mary's Dam southwest of Lethbridge.

(*Continued from page 16*, "100 Years of Cattle Feeding.")

Lloyd Dickens finds, like his grandfather did, that there are many risks involved before a profit is made in feeding cattle. And that good management is essential.

Lloyd's records show that his operation is similar to other records made in the area.[1] Total production costs for marketing cattle at a 1,000-pound weight in 1962, averaged $228.10 per head. This included the cost of the cattle, feed, interest on borrowed money, and all other costs associated with this enterprise except a labor return to the owner.

Purchased cattle weighed about 650 pounds, were fed to a market weight of about 1,000 pounds, and sold for an average of 25 cents per pound, or $250 per head. Last year the farmers in the area invested more than $159 million in 700,000 head of feeder cattle, and they sold for a total of approximately $175 million.

Other Project Benefits

With some imagination, one can visualize the economic benefits of this production. For instance, interest charges on borrowed capital from banks to feed the cattle averaged a total of $3,570,000. Other benefits are reflected in sales of farm equipment and services.

In 1961, the 720,000 acres of land irrigated by the Colorado-Big Thompson area produced feed crops valued (before feeding) at almost $20 million. Nearly all of these crops went into livestock feeding.

Outside purchases were made of shelled corn, milo, concentrates, maise, minerals, and salt. An additional $7 million was added to the Colorado-Big Thompson feed-crop production value by marketing it in the form of livestock.

Lloyd Dickens finds it is necessary to purchase about one-half of his shelled corn needs, or feed of equivalent value. Most of these feeds from different areas also are grown on irrigated lands in other parts of Colorado, Nebraska, Kansas, and Texas.

The Dickens farm and its neighbors in the Colorado-Big Thompson project area, have been able to make significant development due to a continuous water supply. They, in turn, have benefitted themselves, other farmers, and many fellow citizens who go to market and buy nourishing beef for their dinner tables. # # #

[1] **"Surveys Show West's Ranches Require Heavy Investments," *Western Farm Life*, 1962, and "Commercial Feed Lot Economic Impact Study," prepared by Reclamation employees in 1960.**

Typical cattle scenes in this irrigated area.

TOUR of SOVIET DAMS

(*Continued from page 4.*)

The captions which follow apply to the pictures on this page which were photographed by members of Secretary Udall's delegation.

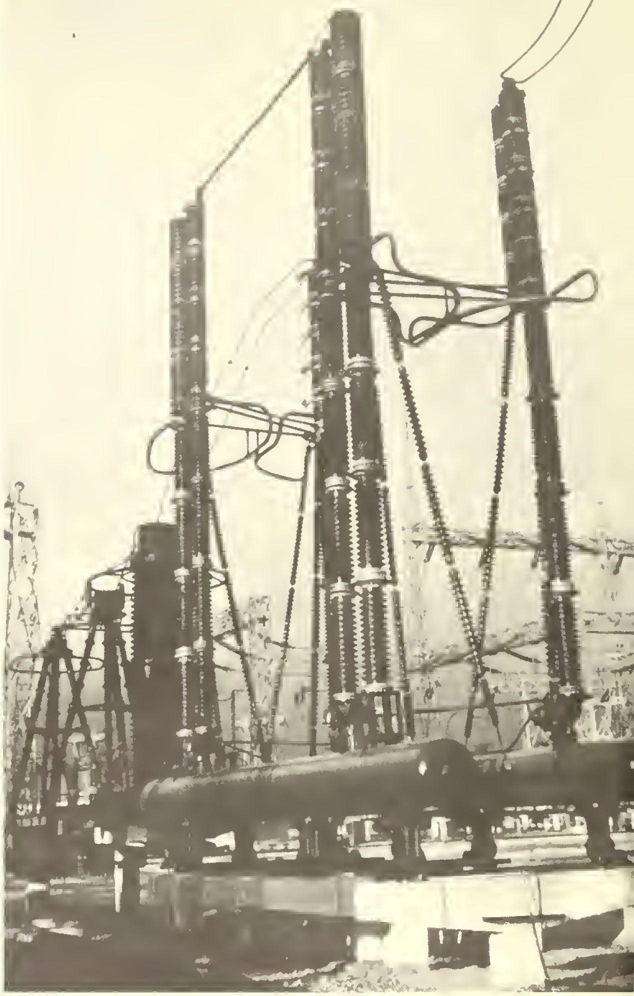
Below—Switches of 500 kv. disconnect type.

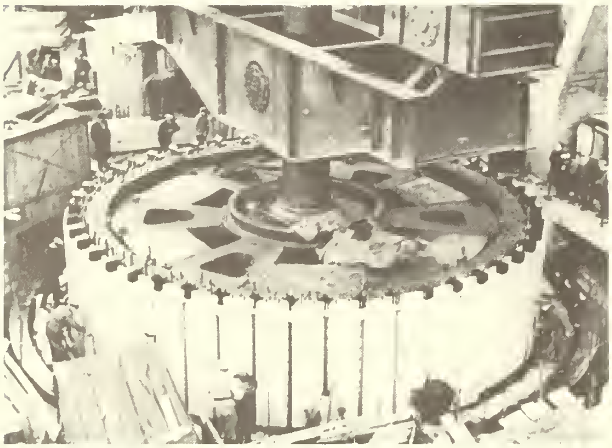
Bottom left—This 225,000 kw. hydroelectric generator rotor is being installed at Bratsk Dam.

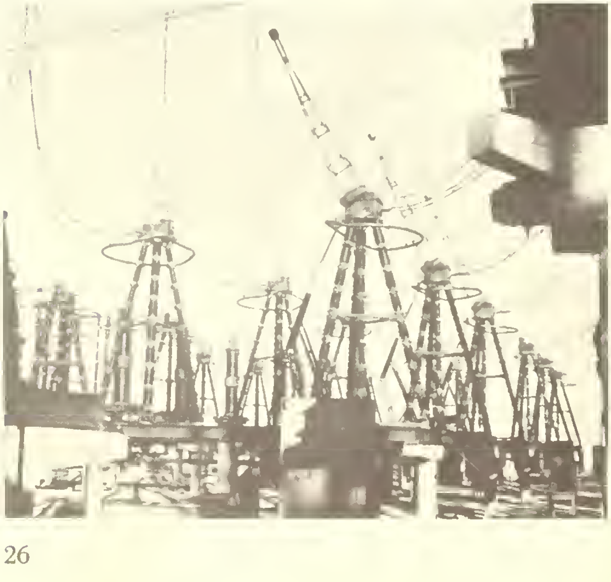
Top right—This is a 500 kv. airblast circuit breaker.

Center right—Familiar window display was seen in a Moscow department store.

Bottom right—A Russian hydrofoil boat which lifts off the water with wings when traveling, is shown on Lake Baikal in Siberia. # # #







With The Water Users

Stanley A. Matzke, Assistant to the General Manager of the Central Nebraska Public Power and Irrigation District since November 1953, (right), and D. E. Hutchinson, Nebraska State Soil Conservationist (left), were recipients of a Distinguished Service Award from the Nebraska Soil and Water Conservation District Association at their annual convention held in October. The awards are made in "recognition of outstanding service to the citizens of Nebraska through outstanding support and generous contribution to the soil and water conservation district program."

In his career of conservation, Mr. Matzke has received many honors. He is credited with many published writings, one of which is an article in the May 1958 *Reclamation Era*, entitled "Ample Water Everywhere But Never Too Much Anywhere." ★ ★ ★

H. P. Dugan Appointed New Director for Region Seven

H. P. (PAT) DUGAN, formerly Regional Director of the Bureau's Region Two in Sacramento, Calif., and former long-time Denver, Colo., resident, was recently appointed Director of Region Seven with headquarters at Denver. Mr. Dugan, a career employee with 25 years of Federal Government service, succeeds John N. Spencer, who retired recently at Denver.

A native of Louisville, Colo., Mr. Dugan obtained his B.S. degree in civil and irrigation engineering from Colorado State University and was Assistant Chief Development Engineer at Denver before moving to Sacramento in 1959.

Mr. Dugan will be the top field administrator for all Reclamation work on the Platte River and Arkansas River basins in Colorado, Kansas, Nebraska, and Wyoming, and for the $170 million Fryingpan-Arkansas Project in Colorado which President Kennedy visited August 17, 1962. Mr. Dugan has demonstrated outstanding leadership in continued development of the great Central Valley Project in California and in his previous assignments during a quarter of a century with the Department of the Interior.

Mr. Dugan, who is 48 years old, joined Interior's Bureau of Reclamation in 1936 and had field assignments in Colorado, Wyoming, Oregon, and Arizona. In the Bureau's Denver office, he was head of the Water Resources and Utilization Section in the Hydrology Branch, and head of the River Regulation Section before his 5-year assignment as Assistant Chief Development Engineer.

During World War II, he was a lieutenant in the Civil Engineers Corps of the Navy. He is a registered professional engineer in the States of Colorado and California.

Mr. Dugan is married to the former Alice Louise Pennock of Fort Collins, Colo. Their daughter Michele is a freshman at Colorado State University at Fort Collins. ★ ★ ★

MAJOR RECENT CONTRACT AWARDS

Specification No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DS-5801	Seedskadee, Wyo	Oct. 12	One 16,000-hp hydraulic turbine for Fontenelle powerplant	Mitsubishi Heavy-Industries, Reorganized, Ltd., c/o Mitsubishi International Corp., New York, N.Y.	$228,160
DC-5814	Weber Basin, Utah	Oct. 5	Construction of Ogden Valley Diversion Dam and 9.3 miles of canal.	Fife Construction Co., Inc., Brigham City, Utah.	347,723
DS-5825	Central Valley, Calif	Nov. 20	Eight pump-turbines for San Luis pumping-generating plant	Hitachi New York, Ltd., New York, N.Y.	3,221,813
DC-5826	Do	Oct. 12	Modification of existing secondary louver structure for fish collecting facilities, Delta-Mendota intake canal.	Gil Construction Co., Pacheco, Calif.	145,394
DS-5827	Colorado River Storage, Colo.	Nov. 15	Two 41,500-hp, vertical-shaft, hydraulic turbines for Blue Mesa powerplant.	Hitachi New York, Ltd. New York, N.Y.	612,659
DS-5828	Colorado River Storage, Ariz.-Utah.	Oct. 31	Four generator-voltage bus structures, two 4,160-volt station-service bus structures, and three 3,750/4,678-kva station-service power transformers for Glen Canyon powerplant, Schedule 1.	Westinghouse Electric Corp., Denver, Colo.	438,560
DS-5828	do	do	Two 500-kva induction voltage regulators, eight 14,400-volt switchgear assemblies, and twelve shunt reactors for Glen Canyon powerplant, Schedules 2, 3, and 4.	General Electric Co., Denver, Colo.	612,919
DS-5829	Missouri River Basin, Mont.-Wyo.	Nov. 26	Four 87,500-hp, vertical-shaft, hydraulic turbines for Yellowtail powerplant.	Mitsubishi Heavy-Industries, Reorganized, Ltd., c/o Mitsubishi International Corp., New York, N.Y.	1,138,900
DS-5831	Colorado River Storage, Colo.	Oct. 9	Two 84-inch ring-follower gate valves for outlet works at Blue Mesa Dam.	United States Steel Corp., Consolidated Western Steel Division, Los Angeles, Calif.	159,638
DC-5832	Missouri River Basin, S. Dak.	Nov. 20	Constructing foundations and furnishing and erecting steel towers for the 146-mile Fort Thompson-Sioux Falls 230-kv transmission line.	Paul Hardeman, Inc., Stanton, Calif.	4,253,200
DC-5833	Lower Rio Grande Rehabilitation, Texas.	Oct. 5	Clearing and construction of earthwork, concrete lining, and structures for rehabilitation of Upper Main canal and lateral systems 6.5, 7.2, and 8.9, and lateral 10.3 to Sta. 1+35.	H&H Concrete Construction Co., Corpus Christi, Texas.	425,286
DS-5835	Missouri River Basin, Mont.-Wyo.	Oct. 3	Two 84-inch hollow-jet valves for river outlets at Yellowtail Dam.	Goslin-Birmingham Mfg. Co., Inc., Birmingham, Ala.	112,289
DC-5836	Missouri River Basin, Mont.-N. Dak.	Oct. 11	Construction of stage 05 additions to Bismarck substation and construction of Custer substation, stage 01.	Donovan Construction Co., St. Paul, Minn.	812,170
DC-5841	The Dalles, Oreg	Nov. 6	Construction of Mill Creek pumping plant, primary discharge line, and regulating reservoir "A".	Cherf and Associates, Inc., and J. M. Foster Co., Inc., Ephrata, Wash.	798,670
DC-5842	Columbia Basin, Wash	Nov. 8	Construction of 4.3 miles of concrete-lined Eltopia Branch canal, Sta. 623+80 to 850+50.	A & B Construction Co., Helena, Mont.	628,403
DS-5843	Colorado River Storage, Ariz.-Utah.	Nov. 27	Furnishing and installing four passenger elevators for Glen Canyon Dam and powerplant.	Pacific Elevator & Equipment Co., San Francisco, Calif.	409,640
DC-5845	Colorado River Storage, Ariz.	Nov. 30	Construction of Pinnacle Peak substation, stage 01	Foley-Jelco, Salt Lake City, Utah.	787,093
DS-5847	Norman, Okla	Nov. 26	Four 6-foot 6-inch by 10-foot high-pressure gate valves, four hydraulic hoists, and two gate hangers for outlet works at Norman Dam.	Goslin-Birmingham Mfg., Inc., Birmingham, Ala.	128,518
DC-5848	Lower Rio Grande Rehabilitation, Texas.	Nov. 28	Clearing, and construction of earthwork and structures for rehabilitation of 3A drain and 4.0A drain control structure.	Dodds and Wedegartner, Inc., San Benito, Texas.	122,838
DC-5850	Colorado River Storage, N. Mex.	Dec. 19	Construction of 24.3 miles of 230-kv transmission lines for the extension of Glen Canyon-Shiprock, Shiprock-Cortez, and Shiprock-Arizona Public Service Company transmission lines.	Reynolds Electrical & Engineering Co., Inc., Santa Fe, N. Mex.	831,789
DS-5851	Colorado River Storage, N. Mex.	Dec. 13	One 100/133/167-mva autotransformer for Shiprock substation	General Electric Co., Denver, Colo.	216,277
DS-5854	Colorado River Storage, N. Mex.	Dec. 19	Five 230-kv and three 115-kv power circuit breakers for Shiprock substation, Schedule 1.	McGraw-Edison Co., Pennsylvania Transformer Division, Santa Clara, Calif.	298,950
100C-574	Columbia Basin, Wash.	Nov. 9	Installation of plastic curtain cutoff and construction of compacted blended earth lining for 1 mile of West canal, Sta. 2407+50 to 2458+00.	Sandkay Construction Co., Inc., Ephrata, Wash.	102,824
200C-508	Central Valley, Calif	Oct. 1	Complete rehabilitation of 10 timber bridges and partial rehabilitation of 21 timber bridges for Friant-Kern canal.	Earle A. Wilson, Sepulveda, Calif.	217,657
200C-512	Central Valley, Calif	Nov. 8	Construction of Columbia canal relift facilities No. 2, including construction of four outdoor pumping plants and concrete pipe laterals.	Jack Campbell, Inc., Fresno, Calif.	190,327

U. S. GOVERNMENT PRINTING OFFICE: 1963 O - 670437

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Major Construction and Materials for Which Bids Will Be Requested Through February 1963*

Project	Description of work or material
'anadian River, Tex.	Five horizontal, centrifugal pumps to be electric motor driven, each with a capacity of 37.8 cfs at a total head of 296 ft for Pumping Plant No. 1; and 15 horizontal, centrifugal pumps to be electric motor driven, each with a capacity of 41.2 cfs at a total head of 228 ft, five units per plant, for Pumping Plants No. 2, 3, and 4. Motors for all pumps to be furnished under separate contract.
Do	Four high-pressure gate valves for Sanford Dam: One 6-ft 6-in. by 8-ft; two 5- by 5-ft; and one 3-ft 6-in. by 3-ft 6-in. Estimated weight: 250,000 lb.
entral Valley, Calif.	Constructing about 15.6 miles of 13,100-cfs-capacity San Luis Canal, Reach 1. Work will also include constructing a reinforced-concrete canal inlet structure with radial gate controls and several bridges. Near Los Banos.
Do	Constructing the Wintu Pumping Plant, an outdoor-type plant having a reinforced concrete-substructure; furnishing and installing four motor-driven pumping units of 100-cfs total capacity, mechanical and electrical auxiliary equipment, mechanical fishscreen and steel manifold. Near Redding.
Do	Constructing about 30 miles of from 10- to 54-in.-diameter pipelines, a concrete-lined reservoir, and two steel tanks. Pipelines to be constructed of noncylinder prestressed pipe, pretensioned cylinder-type concrete pipe, mortar-lined and mortar-coated steel pipe, asbestos-cement pipe, or concrete pressure pipe. Cow Creek Unit, near Redding.
Do	Three vertical-shaft, adjustable-blade, mixed-flow pumps, each rated 2,200 cfs at 125-ft total head; and three vertical-shaft, centrifugal pumps, each rated 2,200 cfs at 125-ft total head, all for Mile 18 Pumping Plant. Motors to be furnished under separate contract.
Do	Six vertical-shaft, adjustable-blade, mixed-flow pumps each rated 700 cfs at a total head of 55 ft to be driven by 360-rpm, 5,000-hp, electric motors for Forebay Pumping Plant. Motors to be furnished under separate contract.
Do	One 350-ton overhead traveling crane for San Luis Dam and Pumping-Generating Plant. Estimated weight: 400,000 lb.
RSP, Arizona	Dismantling about 22 miles of an existing 230-kv, single-circuit, steel tower transmission line; and constructing concrete footings, furnishing and erecting double-circuit steel towers, and furnishing and stringing 954 MCM, ACSR conductors, and 3/8-in. overhead ground wires, for about 22 miles of 230-kv, double circuit Pinnacle Peak-Mesa Transmission Line.
Do	Constructing concrete foundations and erecting four each of eight types of 230-kv, single-circuit, guyed, and self-supporting, steel and aluminum towers for the Glen Canyon-Shiprock Transmission Line. Near Kayenta.
RSP, Colorado	Constructing Morrow Point Dam, about a 350,000-cu-yd thin-arch concrete structure 465 ft high and 720 ft long, and appurtenant features, including an outlet works and spillway through the dam. Work will also include constructing an underground powerplant, 57 by 250 by 120 ft high, to house two 60,000-kw generators. On Gunnison River, about 22 miles east of Montrose.
Do	Constructing the Hayden Substation (Stage 01) consisting of a 37- by 65-ft concrete masonry service building and a 50- by 96-ft concrete masonry garage, and concrete foundations; furnishing and erecting steel structures; furnishing and installing one 3-phase, 230/138-kv, 90,000-kva autotransformer, four 230-kv, six 138-kv, and three 14.4-kv circuit breakers, nine single-phase, 13.2-kv, 7,000-kva shunt reactors, and associated electrical equipment; and grading and fencing the substation area.
CRSP, Colorado	Constructing a steel frame, metal panel, glass, and brick masonry wall building with a full basement, full ground floor, and partial second floor. The building will have about 33,500 sq ft of floor area and will house a dispatching center as well as administrative offices. At Montrose.
CRSP, New Mexico	Constructing the Shiprock Substation (Stage 01) consisting of a concrete masonry unit service building and concrete foundations; furnishing and erecting steel structures; installing one 3-phase, 167-mva, 220/115-kv, autotransformer, five 230-kv, three 115-kv, and two 14.4-kv circuit breakers, six 7,000-kva shunt reactors, and associated electrical equipment, major items of which are to be Government furnished; and grading and fencing the area.
Columbia Basin, Wash.	Eight vertical-shaft, single-stage, turbine-type centrifugal pumping units each rated 10,000 gpm at a total head of 95 ft driven by 880-rpm, 300-hp, electric motors for the Grand Coulee Powerplant.
Florida, Colorado	Earthwork and structures for about 14 miles of unlined laterals with bottom widths varying from 7 to 2 ft. Near Durango.
Gila, Ariz	Constructing about 3.5 miles of 5-ft bottom width concrete-lined South Gila Canal and about 7 miles of 30- to 48-in.-diameter cast-in-place concrete pipe. Near Yuma.
MRBP, Kansas	Three automatic wire-rope hoists, including floats and float-well guides, for the spillway radial gates at Norton Dam. Estimated weight: 85,000 lb.
MRBP, Montana	Constructing about 9.7 miles of canal with bottom width varying from 13 to 8 ft, about 2 miles of which will be lined with asphalt membrane lining, and constructing about 31 miles of laterals, wasteways, and drains with bottom widths varying from 10 to 3 ft, about 10 miles of which will be lined with asphalt membrane lining. East Bench Unit, near Dillon.
Do	Two 25- by 64.4-ft radial gates for Yellowtail Dam. Estimated weight: 530,000 lb.
MRBP, Nebraska	Earthwork and structures, including five small pumping plants, for about 14 miles of canal with bottom widths of 20 and 18 ft and about 42 miles of laterals with bottom widths of 4 and 3 ft. Farwell South and Upper South canals and laterals, near St. Paul.
MRBP, South Dakota.	Constructing the James Diversion Dam, a reinforced-concrete structure with a concrete ogee overflow section about 50 ft long and a slide gate controlled sluiceway section with aprons and wingwalls On the James River, near Huron.
Norman, Okla	Constructing about 30 miles of 18- to 36-in.-diameter pipelines for hydrostatic heads of from 25 to 400 ft. Near Norman.
Seedskadee, Wyo	Constructing the 87- by 60-ft Fontenelle Powerplant, a reinforced-concrete substructure and intermediate structure with structural-steel superstructure, metal wall panels and steel roof decking, to house one 16,000-hp reaction turbine operating under a 94-ft head at 150 rpm with a 10,000-kw generator. Work will also consist of constructing about a 200- by 75-ft switchyard. On the Green River about 24 miles downstream from La Barge.

*Subject to change.

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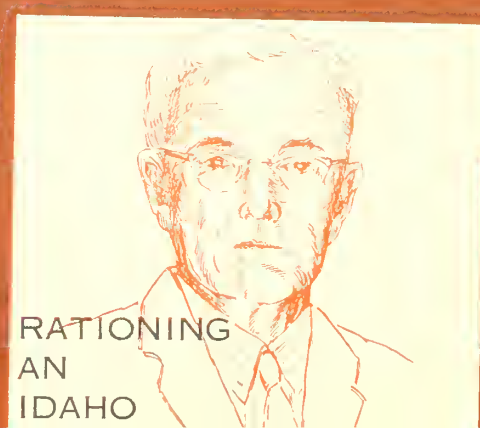
Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington 25, D.C. Use of funds for printing this publication has been approved by the Director of the Bureau of the Budget, January 31, 1961.

Reclamation ERA

"SEE IT YOURSELF"

DAM FOUNDATIONS

PROJECT GOES MODERN



RATIONING AN IDAHO

MAY 1963

The Reclamation Era

MAY 1963 VOLUME 49, NO. 2

Mrs. Paul McCrary pushes button to hear the recorded tour talk.

'SEE-IT-YOURSELF' at Grand Coulee Dam

by BOB DEURBROUCK
Columbia Basin Project

THE Columbia Basin project in central Washington reads like an Horatio Alger story. Conceived by a few local citizens almost 50 years ago, construction began on the chief multipurpose feature of the project—Grand Coulee Dam.

As the first kilowatts from the growing project were snatched up by industries of the Pacific Northwest and the first patches of green appeared in the brown landscape, the status of the project grew. Today, the Columbia Basin project is a substantial citizen of the Nation.

To tell the story of the Columbia Basin project to the increasing crowds who go to inspect this portentous water operation, several types of visitor programs have been used.

These programs underwent some variations over the years—a guide's explanation given at an overlook point and visitor facility—a lecture at a tour center followed by a tour through one of the dam's two powerhouses—a miniature railroad, from 1946–50, to transport tourists to the powerhouse. Throughout the 1950's the tour program did not change much, the number of visitors increased and a staff was maintained comprising five year-round guides during the summer months and five additional guides and a few guards.

Because of the expense of maintaining this staff of guides and guards, beginning in 1953, it became necessary to charge each visitor 30 cents to tour the powerhouse. Although the 30-cent charge netted about $30,000 a year, it caused a sharp drop in the number of persons taking the guided tour, even though the number of visitors to the Grand Coulee area continued to increase.

Visitors Omitted Tour

In 1953, it was estimated that more than a half million visitors came to the dam, but only a third of these visitors took the guided tour through the powerhouse, and probably very few of this number left the dam having gained an understanding of the multiple purposes of the total Columbia Basin project development. It was felt that inherent limitations of the guided tour were undoubtedly the reasons for the drop of persons taking it.

Meanwhile, the Parker and Davis Dams along the Arizona-California border and the Hungry Horse Dam in Montana were treating the public to a different kind of tour—a self-guided type incorporating taped, pushbutton lectures at points of interest. The visitors could move as slow or as fast as they wished, talk as much as they liked, and photograph as much as they liked. Of particular interest to project officials, a minimum of personnel was required to tell the story of the

The McCrarys look like they enjoy taking the tour.

purposes and history of the structure, eliminating the need for an admission charge.

In 1961, after a thorough investigation, the 30-cent tour charge was dropped, and the transition from guided to self-guided tours at Grand Coulee Dam began. Directional tour signs were installed throughout the proposed tour route. Pushbutton speakers were installed, and in one tour stop area, acoustical tile was necessary to muffle the roar of the whirling generator shaft. Elevators throughout the tour route were converted to fully automatic vehicles which would stop only at the tour stops. For safety and security reasons, barriers were installed at critical spots to restrain the visitors.

More Visitors Tour

By the latter part of 1961, visitors to the dam were on their own—and they liked it. The number of visitors that toured the powerhouse increased by about 30,000. Last year, with the help of the World's Fair in Seattle, over a quarter of a million persons toured the dam. Despite the loss of the 30-cent tour charge, 1962 self-guided tour costs showed a substantial savings over the annual costs of the guided tours. This year, friends and neighbors of last year's visitors are expected to tour the dam in self-guided style as the result of word-of-mouth advertising.

Tours begin at the Tour Center on the east bank of the river in view of the dam spillways. Here the visitor is greeted by one of the project's three guides, the only permanent tour personnel at the dam. A picture screen in the Tour Center is activated by a button, and the visitor is presented with a short presentation of colored slides synchronized with a taped talk that tells the purpose and benefits of the irrigation project—a story that is all too easily overlooked by the visitor viewing the huge dam. Groups who are interested may also hear the guide present a brief talk about the construction of the facilities, illustrating his remarks with a segmented model of the dam. The guide then directs the visitors, who are now oriented to the purpose of the whole project, to a powerhouse, where the new self-guided tour actually begins.

Just Press a Button

They park in a large lot, walk through an automatic tourist counter, and press a button at the first tour stop just inside the powerhouse. Here, a taped voice responds describing the physical arrangements and facilities of the self-guided tour. The sightseer is now on his way. From this point, a walk along a well-lighted sloping ramp leads to a self-operating elevator that takes the visitors to tour stop No. 2, one of the dam's many galleries. A taped voice explains the purpose of the internal galleries, the tunnels that allow workmen easy access to the interior of the dam. Prior to the self-guided tour, primarily due to time limitations, visitors were allowed to tour only the powerhouse, not the dam itself. Next stop is at the top of the dam via the elevator for a spectacular view of the Columbia River plunging over the spillway to the froth below.

Tour stop 4 is a balcony view where the tap[ed] voice provides details of the size and capacity o[f] Grand Coulee's giant generators. Next, from th[e] governor gallery, visitors see an awesome closeu[p] behind a safety glass barrier of a whirling, gleam[-] ing generator shaft that performs nearly all yea[r] round.

They Take Seats

At the main control room, the visitors may si[t] down, listen to the pushbutton guide and watc[h] the men operators checking and regulating th[e] controls of the powerplant generators. Just out[-] side the control room gallery the visitor overlook[s] the transformers and the spillway. From her[e],

gns direct the visitor to the exit room, and the
arking lot.

Before the beginning of the self-guided opera-
on, the parking lot was the end of the visitor's
ur. Any additional stops would have meant the
roject's hiring of more guides and guards, and
ny great deviation in the time schedule would
ave caused a traffic problem to following groups.
ow, however, since every visitor is his own guide,
lorful, animated exhibits have been added to the
ur, showing the design and multiple effects of
e gigantic water resource system.

A Scenic Drive

So, the tourist may take a scenic drive over the
p of the dam, and perhaps stop at one of the
rking places in the middle of the dam, for a
cture or two. Green tour signs direct the visitor
to the dam's pumping plant parking lot. In the
ception room of the pumping plant the push of a
tton will animate a large topographic map and
d the visitor for 5 minutes from the Canadian
efields to the southernmost Columbia Basin proj-
t lands at the confluence of the Snake and
olumbia Rivers near the Oregon border.

Around the walls of the pumping plant recep-
on room are a series of murals that depict the
eologic and human history of the Columbia Basin
roject. An alternate 15-minute tape that is
metimes used coordinates these murals into the
ory told by the map.

Cases of photographs, Indian artifacts, rocks,
aps, and economic data at the base of the murals
plain other aspects of the multipurpose project
ory.

A balcony view in the pumping plant shows the
x huge 65,000 hp. pumps that lift waters of the
ver 280 feet into a feeder canal above the pump-
g plant. During the irrigation season, these
umps can start a billion gallons of water a day
n its way to the project's irrigated lands.

The ride back to ground level is the end of the
lf-guided tour of the dam and its facilities.
owever, the summer visitor who stays until
ghtfall will be rewarded with a final breath-
king sight. From May to September, between
usk and 11 p.m., a large bank of colored lights,
ynchronized with a program of music, plays
cross the surface of the plunging waters—the
erfect end of a day of sightseeing at Grand
oulee Dam! # # #

(*Photographs by Gene Hertzog*)

TOU
ELEVA

RECLAMATION
Technical Leadership-2

RECLAMATION COMMISSIONER FLOYD E. DOMINY *introduced a series of four articles on "Reclamation Technical Leadership" in the February 1963* Reclamation Era. *In that issue, the first of the series was "Computers Work in Reclamation." You will note that each of the articles highlights recent important Reclamation Firsts which were achieved by Reclamation engineers. These four articles represent more than 40 "Firsts" which are described in the semitechnical presentation entitled* Bureau of Reclamation Leadership in Design and Construction of Water Resources Projects.

The present article, "Being Sure About Dam Foundations," gives a layman's eyeview of how the Bureau of Reclamation improves its calculations of foundations and abutment rock where dams and other structures are built.

Being SURE about Dam Foundations

BUREAU engineers are improving their design and construction methods by utilizing advanced techniques of testing foundations for structures on Reclamation projects. For example, in-place measurements of elastic properties of rock at structure sites are expected to result in safer, more efficient, and economical designs.

The engineers point out that improvements in design practice and standards used for major engineering structures, such as dams, bridges, tunnels, and canals, are closely allied with improvements in the study of subsurface conditions. The improvements are also allied with engineering data on the strength of the foundations on which such works will be built.

Knowledge of foundation conditions at concrete dams is particularly emphasized, as failures of several mass concrete dams in foreign countries have resulted from unstable foundations rather than from structural weaknesses in the dams.

Reclamation geologist, David Allen, checks a 200-ton hydraulic jack at a Yellowtail Dam tunnel.

Yellowtail and Morrow Point

Measurements of the deformation of the abut-ent rock recently completed at the site of Mor-w Point Dam in Colorado and the investigations irrently in progress at Yellowtail Dam in Mon-na are important forward steps. Improved quipment has been developed by which loads at ese sites are induced in the rock by hydraulic cks exerting tremendous pressures against the ck.

Tunnels are excavated in the abutment rock of e dams, and jacks are placed on concrete pads the floors of the tunnels. Pressure is then ex-ted against the tunnel roofs and floors, resulting "squeezing" of the rock to simulate loads that ould be applied by the completed dams.

After a continuous test period of about a week, uring which pressure readings are regularly ade, the jack pressures are removed, and the bility of the rock to "spring back" to its original ate is measured and recorded. A separate test ycle is made for various pressures.

Deformation in rock is measured on a gage in-alled in the floor of the tunnel below the center f each load. This permits measurements of in-astic properties as well as elastic properties of oundation and abutment rock, and makes possible more accurate prediction of rock behavior under ads. The gage measurement is correlated with nnel diameter measurements and with other ob-ervations and laboratory tests.

Glen Canyon Dam Tests

Current investigations were preceded last year y intensive testing of abutment rock at Glen Can-on Dam which is under construction on the olorado River storage project in northern Ari-ona. To obtain additional information on the hysical properties of the left abutment of the 10-foot-high dam, Bureau engineers conducted sts in a 6-foot-wide by 8-foot-high tunnel exca-ated into the rock wall 300 feet below the canyon m.

Two hydraulic jacks having a total capacity of 00 tons were installed for a series of tests which ave answers on the elastic recovery of the rock nd other properties of importance to the engi-eers. Information from the tests will be useful lso in placing concrete at the abutments near the p of the dam.

Data from the load-bearing tests at Glen Can-

Data on exerted pressure is recorded.

yon Dam are being correlated with data from earlier investigations at Yellowtail Dam, a 520-foot-high concrete-arch structure under construction on the Missouri River Basin project.

In turn, the studies at these dams aided designers in their investigations of the rock at Morrow Point Dam, a 465-foot-high thin-arch concrete structure. Construction of the dam, a feature of the Curecanti unit of the CRSP, is scheduled to begin this spring.

Underground Powerplant

Investigative work for Morrow Point Dam was carried out in two tunnels, one in each abutment. A separate exploratory tunnel was excavated downstream in the left abutment to aid in the study of the rock surrounding the underground powerplant to be built with the dam. This will be the Bureau's first underground powerplant.

The in-tunnel jacking tests of rock at the three damsites are being supplemented and coordinated by testing rock cores which are drilled out and sent to the Bureau's research laboratories in Denver for analysis, and by seismic testing of the rock in place.

The seismic testing method consists of setting off a small charge of dynamite in a drilled hole. The velocity of the resulting shock waves induced in the rock by the minor explosion is recorded and measured by geologists who can then evaluate the shock waves in terms of structural properties of the rock.

The correlation of the three techniques of rock analysis—jacking tests, seismic measurements, and laboratory studies—are increasing Bureau engineers' fundamental knowledge of rock foundations for dams and other structures. The overall aim of this concerted research effort is to achieve increased safety, economy, and efficiency on Reclamation dams and other Bureau structures. # # #

IRRIGATORS' "How'd you do it?" SHOP

Coating equipment with paint and zinc compounds

Maintenance of pipes and repairing them with sawdust, bands and plugs

Uses of epoxy resins, insuring bonding, preventing early hardening, dangers in adding solvents

Safety procedures that pay off

by HOLLIS SANFORD, Chief of the Division of Irrigation Operations, Denver, Colorado

(Mr. Sanford's article presents highlights of the second Irrigation Operator's Workshop which was held last December at the Denver Reclamation Engineering Center. Representatives of irrigation districts from several States and Bureau specialists participated in the discussions, resulting in a worthwhile conference.)

(The first Irrigation Operator's Workshop was held in late 1961 and was reported in a series of interesting articles in each of the four 1962 issues of the *Reclamation Era*.)

"ONE of the most valuable things about the Workshop is the firsthand exchange of information by the people who actually direct the operation and maintenance of distribution systems," commented Harry E. Van Every, Water Maintenance Engineer of the Bureau of Reclamation at Sacramento, Calif.

Protective Coatings

The irrigation operators discussed protection against corrosion of iron and steel structures and the importance of correct selection and application of coatings. Deterioration as a result of faulty application of coating often occurs. For this reason, protective coatings should be selected and applied with care.

On the Delta-Mendota Canal in California, irrigation operators have found that galvanizing effectively protects farm turnout slide gates. O&M forces pull the gates and send them to Oakland for galvanizing where the cost of galvanizing is about 5 cents a pound. Operators pointed out that this maintenance is practical and it conserves manpower.

During one of the Workshop sessions, participants were shown pieces of dried paint that had come loose from the interior of a water storage tank. From examination, it was evident that the paint did not adhere because the steel surface had not been properly prepared prior to applying the first coat.

This demonstration emphasized the necessity of selecting good protective coating materials, making sure that the surfaces to be coated are properly prepared, and of carefully applying the paint.

One type of inorganic zinc coating, a proprietary compound, was discussed. The coating had been applied on gates in the Yuma, Ariz., area a few years ago and was continuing to provide good service. However, in more recent applications the coating rusted after a short period of exposure

Engineer J. C. Schuster points out to a Workshop group features of the demonstration model of canal turnouts in the Bureau's Hydraulic Laboratory in Denver, Colo.

The conclusion of the Workshop conferees was that the manufacturer may have changed the formulation of the coating without informing the consumer of the change. Irrigation operators must keep themselves informed of such changes.

Rigid inspection of repainting operations is important, a participant from Nevada emphasized. Some coatings are not applied as they should be. Inspection is particularly important where the coating may be applied by inexperienced painters or by contractors whose prices in bidding are unusually low.

Repair and Maintenance of Pipe Systems

For temporary repairs of small cracks in pipelines which must remain in operation, sawdust, especially if it is finely ground, is an effective sealant. Several irrigation districts have restricted the use of sawdust for repairs, because it may clog sprinkler systems. At best, use of sawdust is a temporary expedient and will probably have to be repeated at regular intervals.

For more serious leaks where service cannot be discontinued, repairs wil be more elaborate and expensive. Whether the pipe is steel or concrete, it must be exposed where the wet spot appears on the ground. Probably the most efficient digging tool is a backhoe mounted on a small tractor.

Extreme care must be taken with steel pipe so that the coating is not damaged by the digging equipment. Steel pipe leaks will, in all probability, be from small holes in the pipe which may be repaired with a redwood plug, similar to a bung in a barrel.

Transverse cracks in concrete pipes may be permanently repaired by one of several variations of banding. Some irrigation operators carefully calk the crack with lead wool and then cover the repair with a reinforced mortar band. Others cover the calking with metal bands which are coated with mortar.

A method which does not require calking is the use of metal bands lined with camelback rubber or Neoprene. The pipe at the break is carefully cleaned, then the band is clamped around the break

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An inservice leaking pipe is repaired with rubber liner, metal band and mortar.

and cinched up until the rubber liner squeezes into the crack stopping the leak.

Preventive maintenance of pipe systems and appurtenant works is important. Concrete pipes should be kept as full as possible at *all* times, and periodic inspections and repairs should be made as needed on interior coatings of steel pipes.

Epoxies for Concrete Repair

Workshop participants expressed interest in the use of epoxy resin compounds for repair of concrete. Epoxy resin compounds, a family of synthetic resins produced by the petrochemical industry, are excellent adhesives. When properly applied, they will bond fresh portland cement mortar or concrete to hardened concrete. Resins will bond hardened concrete to hardened concrete and they are useful in patching broken, eroded, or damaged concrete surfaces. (See the article "Epoxy Resins—New Aids for Water Users" in the November 1961 *Reclamation Era.*)

Workshop participants discussed an unsuccessful experience of cementing precast curbs to a precast bridge by epoxy mortar, where failure had been due to the missing prior application of a bond coat (a primary coat of epoxy resin).

Recommendations by Bureau specialists in such use of epoxies were that both surfaces should have been coated with a bonding coat, and if enough roughness existed, mortar should have been applied to fill the area, using confining forms to maintain contact of the materials. In all cases, epoxy mortar or a concrete patch should be applied to the bonding coat while it is liquid fresh.

Another participant stated that on a concrete repair job on his project, the epoxy set up too quickly. Project forces had applied the epoxy in a summertime temperature of about 110° F. As the ideal temperature is about 70° F. or 60° F., Bureau laboratory engineers explained that for future repairs, cool the area where the epoxy would be applied, possibly by working at night.

Discussions revealed that epoxy repairs have failed because they contained solvents. Epoxy materials which are diluted with solvents are weakened.

Conferees were reminded that although solvents are useful for cleanup of tools, they are dangerous to use for removing epoxy from a workman's skin, as they will spread the epoxy and cause it to penetrate. For proper safety, any epoxy contamination must be removed from the skin by immediately wiping with a disposable material, preferably a paper towel, followed by a thorough washing with soap and water.

Successful Safety Practices

In sessions with the Bureau's Chief Safety Engineer, H. S. Latham, Workshop participants discussed ways of improving operational efficiency and reducing costs through the application of practical safety measures on irrigation projects. Mr. Latham briefly outlined steps that have been found effective:

. . . Each new employee should receive proper indoctrination in his job and the attendant hazards and safety requirements.

. . . A preemployment physical examination should be given each new employee to determine

f he is physically capable of performing his assigned duties.

. . . A safety committee, consisting of a few top supervisors, should meet monthly to review the safety record and to determine safety policy.

. . . "On-the-job" safety meetings should be conducted each week at a specified time by foremen and supervisors. These should preferably be -minute meetings conducted each Monday morning.

. . . First-aid instruction should be provided for *ll* field supervisors and ditchriders to promote a safe work attitude and to assure that proper emergency care will be given to injured employees or to the public.

Each Bureau region employs a full-time safety engineer who is always willing to assist in initiating effective safety programs in any irrigated district. He can be useful particularly in providing first-aid training and securing material for conducting weekly "toolbox" safety meetings.

Under an agreement with the Bureau of Mines, the Bureau of Reclamation is training key personnel as qualified first-aid instructors. Every Reclamation project now has, or shortly will have, qualified first-aid instructors.

Some district representatives indicated that they planned to take advantage of the first-aid training program, utilizing Bureau instructors to interest district employees in first aid.

Several indicated an interest in setting up local water safety councils in their districts, within the framework of Operation Westwide. This is a program jointly sponsored by Reclamation and the American Red Cross to secure public cooperation and support in organizing and carrying out an effective water safety campaign.

Workmen wear rubber gloves and remove epoxy mortar from paddle with spatula.

A representative of the Contra Costa Water District in California stated that the district was vitally concerned with the protection of the public near the Contra Costa Canal and was employing deputy sheriffs to patrol the canal. Another district had been successful in securing enactment of a statute providing protective fences between its canal and property being developed for residential use.

In summarizing the Workshop, G. G. Stamm, Chief of the Division of Irrigation and Land Use, said: "Irrigation is a dynamic business. It is constantly changing as new materials' new equipment, and better methods are developed. Making irrigation work . . . is fundamental to the success of the Reclamation program and to the individual farmers who compose it. Let's help each other to make our irrigation systems work." # # #

Bureau and Region 7 *TOP ALL* Safety Records

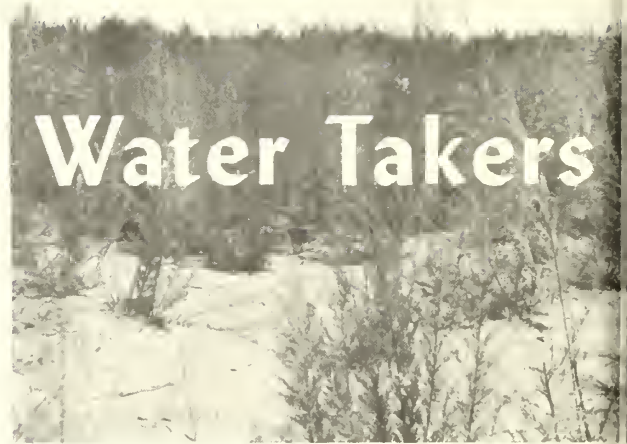
As a direct result of emphasis placed on the safety effort, Reclamation completed 1962 with the lowest Government and contractor accident frequency in its 61-year history.

Bureau employees completed the year with an accident frequency rate of 5.2 disabling injuries per million man-hours, representing the lowest rate ever attained in Reclamation history, and a 1-percent reduction in lost-time injuries as compared with the previous year. This Bureau report was made in *Safety Record*, December 1962.

Achieving the best 1962 accident record reported by a region in Reclamation history, Region 7 became the second recipient of the Commissioner's Annual Safety Award. This region's accident frequency rate of 1.9 and a severity rate of 21 represented only five disabling injuries in the 2,665,668 man-hours worked.

The Safety Award was established in 1961 as a means of recognizing the region which had the most exemplary safety record and was won that year by Region 4. # # #

working against Water Takers



by JOHN T. KRISTL
Hydraulic Engineer,
Area Office,
Albuquerque, N. Mex.

THE Bureau of Reclamation, under the immediate direction of the Albuquerque Development Office, planted and irrigated slightly more than an acre of water-loving tamarisk or saltcedars, as they are called in some areas. They are classed as phreatophytes because they obtain the majority of their moisture supply from ground water rather than rainfall.

Why plant and encourage growth of one of the hardiest water-wasting plants in the Southwest? This is the main question being answered in this article.

The Bureau's planting of tamarisk plants was successful with about 98 percent survival, and a growth of from 4 to 7 feet in height during the first growing season. But the goal of our scientists and engineers is to devise economical ways to eliminate these from the Southwest where they flourish and consume great quantities of water that is needed for many beneficial purposes.

Tamarisk, Tamarix species, was introduced into this country from the Old World about the middle of the 19th century, and was sold as an ornamental shrub. During the early part of the 20th century, this aggressive plant was found growing along natural stream channels. It adapts phenomenally to varying climate, soil, and moisture conditions and in infesting and spreading in parts of the Southwest.

In many areas, other phraetophytes have been replaced by saltcedars and large sums of money have been and are being expended for their control.

The Albuquerque Development office reviewed the records of all available studies. As a result, a prototype study area was selected for the purpose of conducting an intensive investigation.

This study area is infested with approximately 9,000 acres of phreatophytes, mostly saltcedars in a 14.5-mile strip varying from several hundred feet to several miles in width along the river. All vegetation inside the area, which is located about 80 miles south of the city of Albuquerque, N. Mex., has been outlined, classified, and the density determined on aerial photographs.

The study correlates three different approaches or methods of determining water use and potential salvage—the inflow-outflow method, the transpiration-well method, and the evapotranspiration tank method.

Inflow-Outflow Method

Gaging stations are located at each end of the area and on the major intervening tributaries to measure the inflow and outflow of surface water. Periodic seepage tests are being made to supplement the measurements of the inflow and outflow.

Transpiration-Well Method

A grid of nonrecording observation wells was installed to determine the monthly fluctuations of the ground water within the prototype area.

Supplementing these observation wells, and also as a means of determining the consumptive use of water, transpiration wells were located in key areas. These wells are equipped with automatic recorders so that a continuous record of the fluctuations of the water table is obtained.

The change in soil moisture above the zone of turation is also measured at each of the trans- ration wells by means of neutron scatter meters obtain records of the total use of water. Pre- pitation is measured at each location.

Data on the inflow-outflow and ground-water vels in the observation wells and the transpira- on wells are being collected to obtain data under e present conditions. After three growing sea- ns, the saltcedars and other nonbeneficial water- king plants will be cleared and the new rate of ater use will be determined under cleared con- tions. A comparison of water use before and ter clearing should give a fairly accurate deter- ination of the amount of water salvaged.

Evapotranspiration Tanks

To supplement the data obtained from the first o methods, a group of nine butyl rubber-lined nks or pits were constructed in 1961 and filled ith soil from the area. These tanks are 1,000 uare feet in area and are 12 feet deep. (See otograph at the bottom of this page.) Six of e tanks were planted with the crowns of salt- dars located in the vicinity, and the remaining ree tanks were left bare to evaluate the rate of aporation from the bare ground at different pths to the water table.

At the side of the tank is a small shed which ouses the water supply inlet pipe, watermeter,

tyl rubber lining is draped over a pipe framework of the evapotranspiration tanks.

Photo taken June 1, 1962, as the saltcedars were just starting to grow in one of the tanks.

and electrical controls. A pipe installed in the center of the tanks contains electrical controls which automatically keep the water table at a predetermined level. (See photograph at the top of this page.) At the present time three of the tanks also are equipped with automatic recorders which continuously record the fluctuations in the water table.

Water consumed by the tanked saltcedars plus evaporation from the surface equals the total water used with the tanks. The amount used by the saltcedars is correlated with the density of the saltcedars and climate data which are recorded at the site.

To obtain a uniform coverage of their growth in the tanks, saltcedars were replanted in the spring of 1962. Good agronomic practices were used in the replanting which resulted in a survival rate of about 98 percent.

In the Southwest, it is hoped that a lot of water will be salvaged and put to beneficial use—every drop of water is important. These studies are being conducted for the purpose of finding out, in perhaps 5 years, what kind of remedial action could be applied against these water-wasting plants, and to bring less waste to our Nation's precious water resources. # # #

(NOTE: Action against the phreatophyte problem was formerly discussed in the *Reclamation Era* in articles entitled "What Has Been Done About Saltcedars at Caballo Reservoir," by T. H. Moser, May 1960; and "Phreatophytes—Water Wasters," by F. L. Timmons, November 1959.)

RA

Regional Director Lauds Snake River's Crandall

This being the Idaho Territory Centennial Year, I think it apropos to mention that the colorful history of this great State is inextricably entwined with the great rivers of the State, and with pioneering men who, over the years, became known as "Mountain Men" and "River Men."—One such man is Lynn Crandall, who, like many an easterner who came West, qualifies with this caliber. He came to the Snake River country in 1916, liked what he saw, and became inseparable with the Snake River Basin from that time forward.

Mr. Crandall's contemporaries have tried, on many occasions, to express their appreciation for his life's work. Every year, beginning in 1930, for 29 years, the water users of District No. 36, without a dissenting vote, elected and reelected Mr. Crandall as their Watermaster, until his retirement on December 31, 1958. During the same period, with the required special approval of the U.S. Congress, he served as District Engineer for the U.S. Geological Survey.

His remarkable career has included many other water-related and arduous assignments. In 1920, he was appointed commissioner of the court in charge of water distribution in the Big Lost River Valley. At the time the controversies over water in this valley were so heated and rough that, in themselves, they provided the subject matter for many colorful Idaho chapters.

Sometimes serving jointly, Mr. Crandall was Custer County surveyor; city councilman and school board member for the town of Mackay; U.S. mineral surveyor for Custer County; and Federal court commissioner in charge of water distribution on the Salmon River and on the Little Lost River.

Mr. Crandall is a rugged individualist, a man who always says what he thinks in as few words as possible—let the chips fall where they may. He believes in answering every letter that comes across his desk the day it is received.

In 1923, he received the Fuentes Gold Medal from Cornell University and, in 1958, the Distinguished Service Gold Medal from the U.S. Department of the Interior.

Mr. Crandall has always taken a lively interest in all natural phenomena and in collecting unusual items. He has gathered an outstanding collection of Indian artifacts. He became interested in the early stage lines of Idaho and acquired an interesting collection of early-day Wells-Fargo and other express company covers.

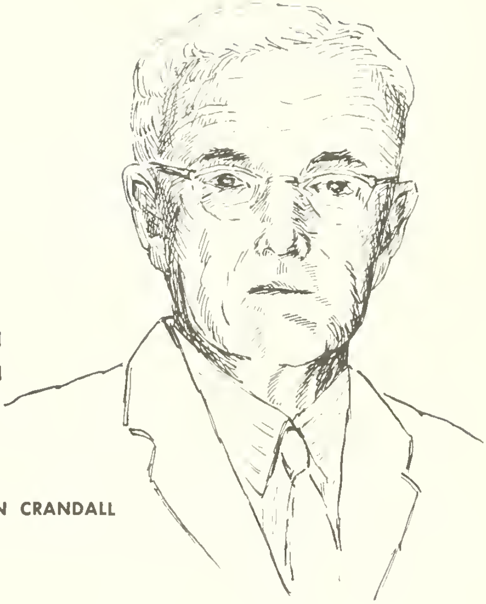
In anticipation of the centennial of Idaho Territory, he has gathered an unusual collection of old maps showing the evolution of Idaho Territory from the Louisiana Purchase to the present.

Retirement did not lessen his interest, but simply gave him the opportunity of transferring more of his waking hours to each of them. He became a consultant on many underground and surface-water problems, not only to the Federal Government but to a number of canal companies. He accepted an assigment as referee in bankruptcy.

Certainly, if there is any one man today who is qualified to discuss the Snake River, that man is Lynn Crandall.

H. T. NELSON
Regional Director
Boise, Idaho

ONING
N IDAHO
TREASURE



by LYNN CRANDALL

FIFTY-ODD years ago, smoke from burning sagebrush in the Snake River area in southern Idaho was commonly seen. Homesteaders had loosened the brush on the land by dragging railroad rails through it, then they raked it into windrows and burnt it. The skyline became blotched with thick sagebrush smoke.

Because most of the settlers were restricted financially and operated only with horse-drawn equipment, it took 20 years or so to get all the land of the larger projects into cultivation.

During the 1870–80 decade, irrigation development on the Snake River tributaries had a small start. In a few years, the first diversions were made from the main river. By 1905 about 581,000 acres were under irrigation on the river and tributaries upstream from King Hill.

Largely due to the Minidoka government project and the Twin Falls North and South Carey Act projects, together with several smaller Carey Act projects, the irrigated area above King Hill doubled by 1915 to 1,170,000 acres. By 1920 this had increassed to 1,400,000 acres and remained at about that figure until 1934, when there was a gradual increase to about 1,600,000 acres by 1950.

Since 1950 there has been a development of something like 600,000 acres of new land above King Hill irrigated by groundwater pumping so that probably there are now about 2¼ million acres of land being irrigated on the Snake River above King Hill.

Early projects were ordinarily able to secure fairly adequate supplies of water from the natural flow of streams, as crops at that time were mostly about 50 percent alfalfa and 50 percent grain. It was not until the Minidoka project started construction in 1905 that provision was made for stored water supplies from Jackson Lake and Lake Walcott Reservoirs.

In 1915, Twin Falls and North Side projects arranged for doubling the storage capacity at Jackson Lake by the Bureau of Reclamation under provisions of the Warren Act, and the dry year of 1919 led to building of Henrys Lake in 1922, and of American Falls Reservoir completion in 1926.

The dry years of the early 1930's, coupled with increasing production of such crops as potatoes and sugarbeets, which required more late season water, resulted in demands for still more storage water as insurance against drought. Island Park and Grassy Lake Reservoirs were built in 1938 and 1939 on Henrys Fork watershed, and Palisades Reservoir began storage in October 1955.

All reservoirs on the Snake River watershed above King Hill have a present total usable capacity of nearly 5 million acre-feet. But in years of deficient runoff, the available water supply is not sufficient to fill them all to capacity.

In earlier years a number of the reservoirs were built by Carey Act construction companies or groups of water users, but for the past 35 years

or so, high costs of construction and complex conflicting interests have resulted in construction by the Bureau of Reclamation.

Mr. Crandall; some years ago.

The more complex reservoir projects have involved long, costly, and detailed studies by Reclamation, followed by negotiations with water users to secure agreement with the proposed plans, then trips by witnesses to Washington to testify before congressional committees, with possible testimony by opposing interests.

At the time of authorization by the Congress of American Falls Reservoir in the early 1920's, the Reclamation program was at such a low level of congressional support that the Congress provided in the authorization bill that canal companies desiring to buy storage in the reservoirs would have to pay cash in advance of construction. Canal companies and irrigation districts floated bond issues and raised the money to comply with this requirement.

Large sums of money are often spent both by Government and by interested individuals before authorization is finally secured from the Congress to build some particular project.

It took over 20 years of investigations to start construction on the Palisades project on Snake River, involving the negotiation of a compact between Wyoming and Idaho, securing agreements between various groups of Idaho water users, and getting congressional approval.

Only when a person has spent the major part of his adult lifetime going through one of these struggles to get some new project authorized and built, can he appreciate all that lies behind a nice-looking dam and powerplant located on one of our western rivers.

The gradual development of natural flow and storage water rights on Snake River over a long period of years has resulted in many hundreds of such rights now in existence, embodied in court decrees, State of Idaho water licenses and contracts between the Bureau of Reclamation and canal companies and irrigation districts.

Operation and Management

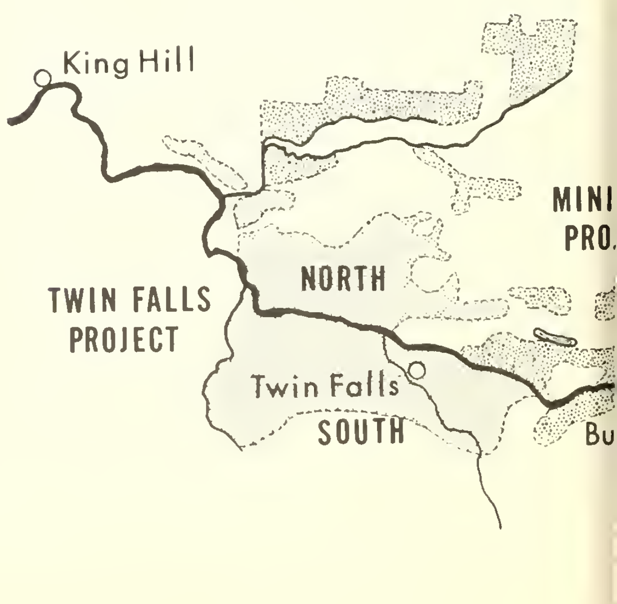
Under Idaho water laws, the State is divided by the State reclamation engineer into water districts, each district comprising an area having a common water supply. Some of these districts located on an isolated small stream may comprise an area of only a few thousand acres or less, while the largest district, such as District No. 36, on the main Snake River includes an area of 1¼ million acres.

On the first Monday of each March the water users in each of these districts meet to elect a watermaster, adopt a budget for the ensuing year, and act on any other matters affecting the operation of the district. Larger districts usually have established an advisory committee to assist the watermaster in passing on controversial questions.

These committees have no established authority, but they usually are able to reach unanimous agreement and are of great assistance to the watermaster in dealing with controversial matters such as stored water transmission losses, reservoir evaporation, bank storage, etc.

The Committee of Nine on Snake River acted as the Idaho Compact Commission in negotiating the Snake River water compact with Wyoming and has also proved to be an effective representative of water users' opinions in dealing with the Bureau of Reclamation on details of repayment contracts, schedules for reservoir operation during both the irrigation and nonirrigation seasons, and other similar questions relating to operations on Snake River.

A much more satisfactory operation results from such a program of prior full discussion by all



parties concerned, rather than to have someone clothed with arbitrary authority in charge of river operation.

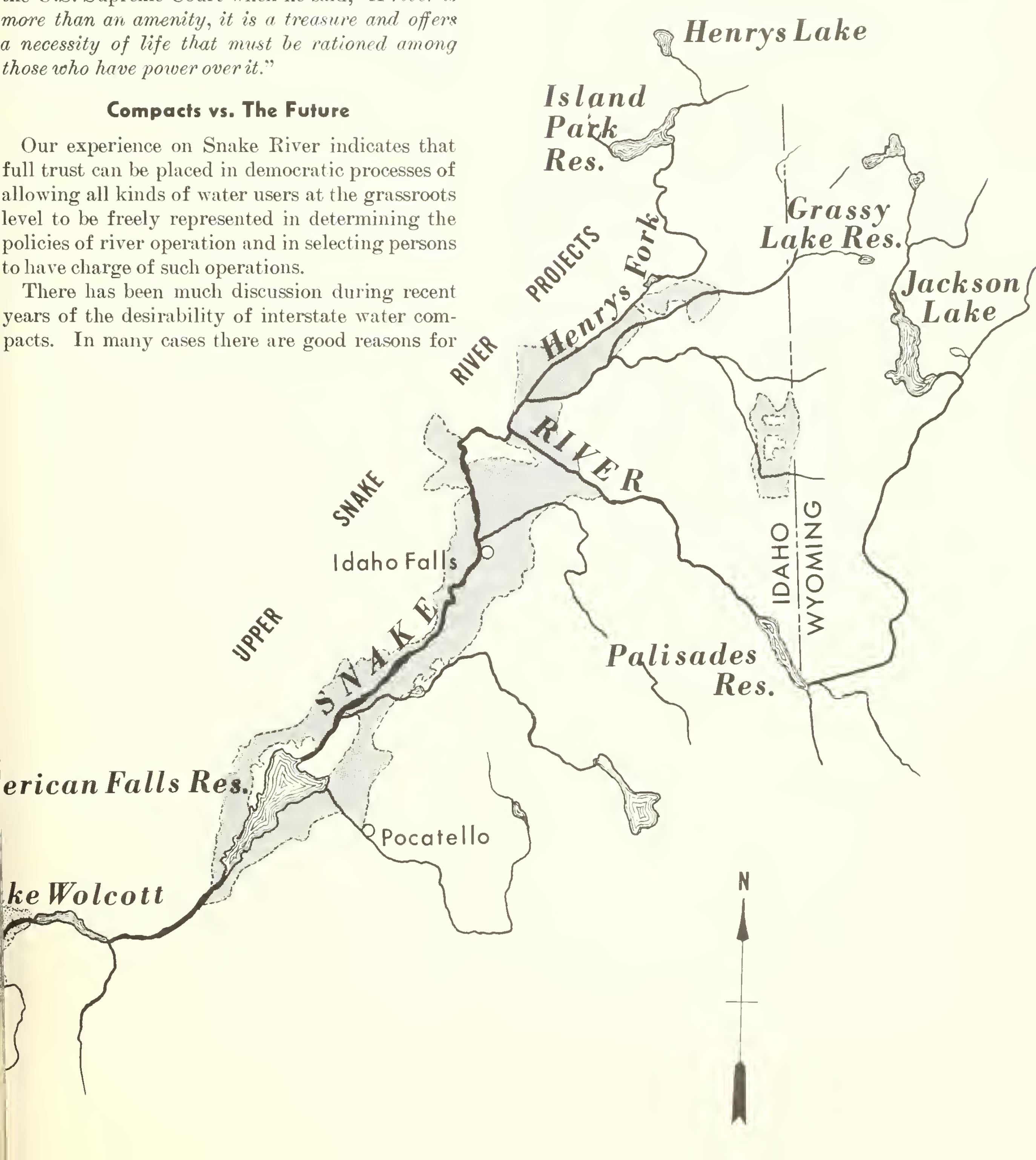
It is only a question of time when our western streams will be fully developed from a water supply standpoint and we will be obliged to give serious consideration to a comment once made by JUSTICE OLIVER WENDELL HOLMES of the U.S. Supreme Court when he said, "*A river is more than an amenity, it is a treasure and offers a necessity of life that must be rationed among those who have power over it.*"

Compacts vs. The Future

Our experience on Snake River indicates that full trust can be placed in democratic processes of allowing all kinds of water users at the grassroots level to be freely represented in determining the policies of river operation and in selecting persons to have charge of such operations.

There has been much discussion during recent years of the desirability of interstate water compacts. In many cases there are good reasons for having such compacts, particularly in the case of small amounts of water and land areas and in allocations on international streams between different countries.

However, one objection to such compacts between States in the case of large areas and complex problems is that no one can lift the curtain that veils the future. No one can predict what river



runoff will be 50 years from now, nor what the most pressing need will be for the available water supply in the future.

Experience with the Colorado River compact affords definite evidence that adoption of a compact on a stream is no guarantee against future troubles with water development.

Over the years, dry seasons occurred, demonstrating that promoters of some projects had been unduly optimistic in their original estimates of water supply, based on too few years of actual runoff records.

Substantial reductions in irrigated acreage had to be made on some projects, generally as the result of litigation between the settlers and the construction company when the matter could not be settled by mutual agreement. Practically all canal companies, except a few with the very earliest natural flow rights, have been obliged to purchase stored water rights to furnish an adequate water supply during late summer months.

The principal new developments underway at present are individually financed projects for ground-water pumping on newly irrigated lands. It is difficult to accurately estimate what additional acreage might be so irrigated, but it may be of the magnitude of another one-half million acres during the next 20 years in the area upstream from King Hill.

Mr. Crandall, left, receiving Distinguished Service Medal in 1958 from Asst. Secretary Fred G. Aandahl.

Joint studies by the Bureau of Reclamation and the Corps of Engineers also indicate that perhaps some 30 new projects on the Upper Snake may be found feasible of construction before the area's water resources can be considered to be fully developed. A number of these proposed projects, however, have controversial features connected with them, and it will take many years to resolve the conflicting interests. # # #

Grant Bloodgood Retires as AC&CE

WITH almost 41 years of Federal service, Grant Bloodgood retired in February as the Bureau's Assistant Commissioner and Chief Engineer. He was succeeded by B. P. Bellport, whose office title became Chief Engineer.

Best wishes were expressed to AC&CE Bloodgood by Department officials and Washington staffers when he visited the Commissioner's office in January. Commissioner Dominy attended the informal honors for Mr. Bloodgood in Denver rather than the Washington well-wishing inasmuch as he was away on official busines when Mr. Bloodgood was in Washington.

In January 1946, he entered the Bureau of Reclamation's Denver Engineering Center as Chief of the Construction Engineering Division, and rose through the years to Chief Construction Engineer and Associate Chief Engineer. He has been Assistant Commissioner and Chief Engineer since March 1, 1958.

Mr. Bloodgood holds the Department of the Interior's Gold Medal for Distinguished Service, and the Army's Legion of Merit and two Bronze Star Medals for military service during World War II.

A native of Newark, Nebr., Mr. Bloodgood graduated in engineering from the University of Nebraska in 1920.

He is a member of the American Concrete Institute, the Society of American Military Engineers, the American Society of Civil Engineers, and serves on the Executive Committee of the U.S. Committee on Large Dams. He is a registered professional engineer in Colorado. # # #

TEDDY ROOSEVELT'S PROJECT *goes* MODERN

President Theodore Roosevelt's visits to the Salt River Valley of Arizona were largely responsible for his strong belief in irrigation which led to passage of the Reclamation Act of 1902. This is the reason settlers on this pioneer multipurpose Reclamation devel-ment affectionately refer to it as "Teddy Roosevelt's."

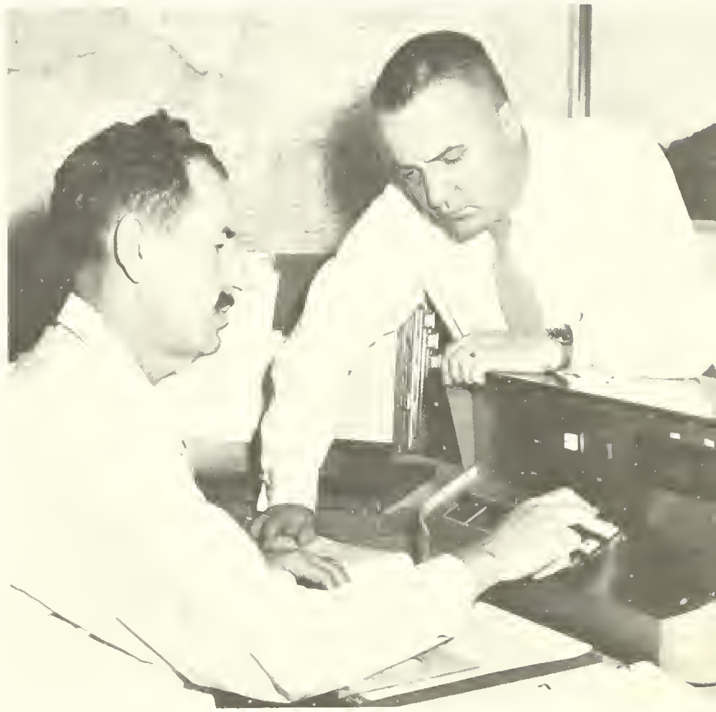
ADC: "ADC (Association Dispatch Center) calling car 36. Emory, (zanjero) car 36."
Car 36: "This is Emory. Go ahead, ADC."
ADC: "This new black box is giving us a reading that indicates trouble at Division Gates."
Emory: "What does it say?"
ADC: "It indicates a sudden raise in the forebay, and that Consolidated Canal is dropping out."
Emory: 'Can't be. I just left Division Gates 10 minutes ago and am traveling up the canal now."
ADC: "Well you had better head back and check. Maybe we can throw this black box in the ditch."
[*Fifteen minutes later*]
Emory: "ADC from car 36!"
ADC: "Go ahead, Emory."
Emory: "Hold on to that black box. I found a log lodged under the radial gate. It was a good thing I got back as soon as I did"

The above incident occurred on the first day the system went into operation after the annual month's dryup. This incident "sold" the value of the remote control to the operating forces, and it confirmed the decision of management to install this supervisory control unit.

A year's investigation was required before deciding on the type of equipment to install.

The location chosen for the first installation is referred to as Division Gates. At this point, the main South Canal is divided into five separate watercourses, three of which are gated for local

by H. SHIPLEY, Associate General Manager,
D. L. WEESNER, Engineer, Salt River Project, Ariz.



Joe Acuff operates the control console of Division Gates at ADC as Howard Durst looks on.

deliveries. The other two are main feeder canals—the Tempe Crosscut to the west and the Consolidated Canal to the east. The junction of the three canals is a critical point due to the following:

(1) Local desert storms drain large amounts of water into the main South Canal in short-time intervals. Since portions of this canal are built in borrow, canal breaks are possible.

(2) Upstream from this point, the Roosevelt Water Conservation District pumps out of the main canal approximately 190 c.f.s. daily. During

At ADC, Howard Durst checks out the radio at Division Gates.

electric failure due to local storms or malfunctioning of the pumping equipment, this flow of 190 c.f.s. will remain in the system, and during peak runs creates a serious problem downstream.

(3) Also upstream, a division of the South Canal starts the Eastern Canal and the remaining flow drops through a hydro unit, which is operated intermittently creating considerable fluctuations at Division Gates.

(4) Many water order changes require continual adjustment.

Button Operation

By explaining the sequence of the operator at ADC on the console, one may appreciate the significance of the conversation that started this article. All information is obtained by interrogating the remote unit. The operator must press the right button to obtain the desired information. These steps are:

(1) Press button W–1 and console indicated level of forebay. On February 19, 1962, at 4:15 p.m., the forebay registered 8.50, indicating higher than normal operating conditions.

(2) Button W–2 reports reading at standard stage recorder, coupled to the digitizer. The reading of 1.50 indicated a difference in flow when compared with the previous reading of 1.90.

(3) The operator then realized that something was amiss, probably a plugup, to cause the raise in the main forebay.

(4) After the zanjero checked the condition and confirmed a plugged gate, he radioed ADC to raise the gate and clear the obstruction.

(5) ADC pressed button R–1. After a foot raise was indicated on the console, ADC reset it to the first reading and then checked his forebay W–1 and the downstream recorder, W–2, putting the canal back *on* order.

After several months of experience, the operator goes through this procedure when checking an unusual circumstance without the assistance of the zanjero in the field.

Editor's Note: *The electronic irrigation control system on the Salt River project has proven to be an efficient and practical worker. Operation of the installation as described in this article will give you a sample of the broader horizons that are coming in view in electronic systems for river control.*

Equipment*

An interesting feature of the equipment is the use of magnetic logic systems. Most people will be able to recall the popular laboratory experiment of a bar magnet directionalizing iron filings clearly showing the magnetic field of flux. Instead of the conventional magnet, ferrite materials are molded in shapes and wired. The units are about the size of a shirt button and are the foundation of the "magnetic logic," which provides built-in, fail-safe reliability.

Engineers designed the equipment to control three individual gates and five telemetering readings on each station. The present console unit has a capacity of 27 stations and can be expanded to 45 stations with very little change and relatively small cost. All of this electronic equipment has a solid state construction with only six relays. The small number of relays involved results in a minimum of moving parts and a relatively low maintenance cost.

The telememory system is entirely operated by 24 volts DC except the actual motorization of the gates. This has the advantage that in case of power failure the full telemetering is still maintained at the station where the power failure occurred, continuing a full knowledge of any conditions that may exist at this location for a period of approximately eight hours. This lost power requires manual operation of the gates.

*See American Institute of Electrical Engineers, Conference Paper CP–61,172, by S. M. Chalmers, electrical engineer for the Salt River project, and Leslie Norde, engineer at Motorola, Inc.

View of Division Gates, above. Right, Emory Hawkes, zanjero in the Division Gates area, checks the water level gage in the forebay.

Telememory Aids

Some of the features of the telememory system are:

(1) *Quiescent operation.*—The system is active only when there is information to report or when a control action is commanded.

(2) *Safety.*—Multiaperture core logic makes the system inherently fail-safe. Cores can remember control signals indefinitely without consuming power. The system will not produce erratic commands in the event of a power failure.

(3) *Continuous alarm.*—Monitoring the remote station automatically initiates an alarm message upon detection of abnormal conditions. The alarm messages can be given precedence over all other transmissions if desired.

(4) *Positive message security.*—Receivers and transmitters are self-synchronized to make absolutely certain that the entire message is received before any control readout action is taken.

(5) *Transmission.*—The telememory system is compatible with all communications media. It can operate over 15-cycle telemetering channels, teletype channels, microwave, VHF (used by Salt River project), or UHF radio, powerlines or powerline carriers.

A very interesting feature of the multiaperature core is that one core can take the place of sometimes 10–12 transistors, and in the event you were using a relay system, this would take the place of possibly twice to three times as many relays.

An important technical feature is the security provisions of the telememory system. It is provided with a number of automatic error-and-malfunction-detection provisions to prevent erroneous messages or incorrect control action from occurring.

Message Checking

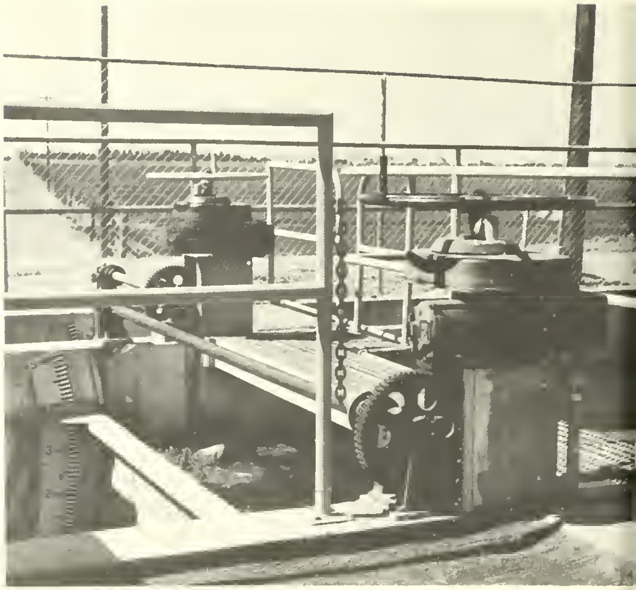
Remote-to-central messages are given a two-part parity check. Central-to-remote messages may go through as many as three parity checks before they are decoded and acted upon. The parity check used for remote-to-central messages consists of counting the code pulses within a fixed interval of time.

Receipt of the first bit of message initiates the count and starts the timing of the message. Any message that does not contain the predetermined number of code pulses and/or not completed within the specified time interval is rejected as invalid.

Acknowledgment of proper effecting of command messages is accomplished by an automatic checkback system. The central station dispatcher depresses a command button, such as "Raise Gate No. 5," on the console. Only after the command has been received and carried out at the remote site does the acknowledging lamp on the button itself light up. Thus an automatic check of remote station equipment is implicit in every central-to-remote transmission.

This system has a wide temperature range. It has been designed and tested for temperatures of $-22°$ F. to $+167°$ F., with a guaranteed operational in a range of $-4°$ F. to $+149°$ F. The remote station equipment is packaged for installation in outdoor cabinet for a dusty area where sometimes the temperature reaches 115° F.

With our experience and that of the Yuma Mesa pumping plant on the Gila project, and the Klamath project, it is conclusive that remote *supervisory control systems* for irrigation projects provide: (*a*) Prompt recognition of emergency conditions and the ability to take corrective measures by positioning gates; (*b*) improvement of normal operations by highly accurate telemetering of water level and gate position to be used in the calculation of water flow, and the required gate position to meet the water delivery schedule; (*c*) control of pumping stations at remote locations; and (*d*) positive control. # # #



Gate in the left section of the picture will operate by push-button or by handwheels.

With the Water Users

Award to Mr. Coles (right) being made by W. E. Welsh, Secretary-Manager, NRA.

NRA President Receives Award

LaSelle Coles of Prineville, Oreg., president of the National Reclamation Association, won an annual Conservation Award sponsored by American Motors Corp. The award, one of eight made to men whose recognized accomplishments were substantially or completely in the field of soil and water conservation, was a plaque which was presented to Mr. Coles at a meeting of the NRA Board of Directors on March 4 in Washington.

Mr. Coles has been secretary-manager of Oregon's Ochoco Irrigation District and chairman of the State water resources board since its formation in 1955. He is also a member of the Columbia Basin Advisory Committee named by Secretary of the Interior Udall in 1961.

Oregon's Governor Hatfield cited Mr. Coles as the man who has done perhaps more than any other Oregonian to advance the cause of water conservation.

★ ★ ★

Facing Sediment Problems

SINCE the beginning of history, man's attempts to make beneficial use of land and water resources have been complicated, sometimes with disastrous results, by sedimentation.

Earliest civilizations were developed near the fans and deltas formed by the deposition of sediment along streams and in lakes.

Almost everyone has been closely associated with various forms of sediment and problems of sedimentation throughout his everyday existence. Recognition of sediment yield problems and the need for corrective action progressed steadily in this country. Congressional action has created various agencies and services to administer flood control and watershed protection programs, and are evidence of the public concern and the desire for remedial activity.

Uncontrolled erosion results in silted reservoirs; clogged distribution systems; scoured stream channels; destruction of fish, wildlife, and recreation facilities; and other visible damages of significant proportions.

Sedimentation is inherent in the development of the water supply of a river basin. The degree to which these problems will affect the design, economics, and project operation must be evaluated in planning stage.

The field of sedimentation is relatively new and much of the sedimentation evaluation on early projects was solely based on judgment. As experience is gained on operating projects (both Bureau and others), a storehouse of sedimentation data becomes available from which it is possible to improve the methods and procedures for evaluating the sedimentation aspects in project planning and development.

Areas with problems such as this, a scene on the Riverton project, can be stabilized through conservation practices.

A sedimented section of the Rio Grande near Mesilla Dam, Las Cruces, N. Mex.

Storage

Sedimentation in reservoirs has become increasingly important. At the time storage dams are planned and designed, an estimate is made of the magnitude of the problem. Even where curtailment of storage capacity is considered to be serious, storage facilities are not constructed unless the benefits to the Nation are substantially greater than the cost of the dam.

For example, provision for sediment storage was a major consideration in the planning, selection, and design of the principal reservoirs in the Upper Colorado River Basin. A basic concept adhered to was that active storage capacity should not be encroached upon by sediment accumulation during the first 200 years of reservoir life.

Glen Canyon Dam and other proposed or existing storage features above Hoover Dam will reduce the flow of sediment into Lake Mead to minor significance.

Canal Sedimentation

Deposition of sediment frequently occurs in the vicinity of the headworks of canal diversions. Provisions are generally made for sedimentation retention basins or installations for flushing works downstream from the canal entrance works. As long as the desired flows can be maintained, a certain amount of silting in unlined canals and ditches is sometimes desirable to reduce seepage.

The Bureau of Reclamation is continually confronted with problems in regard to sedimentation on its many projects. The principal features requiring sediment investigation studies are (1) reservoir sedimentation, (2) sediment at diversion dams, (3) channel stability problems, and (4)

When operating, the water level comes to the top of this desilting equipment located near Imperial Dam on the Colorado River. Clear water is moved to irrigate fields while the silt is returned to the river.

problems associated with the design of structures.

The generalized problems arising throughout the field of sedimentation are receiving widespread consideration, both in the field and laboratory by Federal, State, and municipal agencies, as well as other entities and private individuals. This point was emphasized at the recent Interagency Sedimentation Conference at Jackson, Miss., where some 93 individual papers were presented and discussed by the 310 persons attending the conference.

It was pointed out that our present knowledge is far from complete. However, the rate of learning is rapid, control techniques are being improved, and the problem is generally recognized as one of great complexity and importance.

Improved by Controls

Erosion, and consequently sedimentation, may be slowed down in many ways, but it can never be entirely eliminated. Paving streets and roads reduces local erosion, and planting leafy crops helps to lessen wind and water erosion on fields. Erosion in streams and rivers can be greatly reduced by channelization and bank protection.

Controlled grazing over our western pastures prevents the reduction of plant cover caused by overgrazing. Runoff control by the construction of small ditches along hillsides allows the waters to seep into the soil mantle and thus aid in the control of erosive factors. These are generally agricultural problems and can provide a measure of control over the production of sediment.

Within economic limits the Bureau of Reclamation controls the transport of sediment to the end that its detrimental effects are minimized and provide for the beneficial utilization of the Nation's resources. # # #

KEY PERSONNEL CHANGED

B. P. Bellport Becomes Reclamation's Chief Engineer

B. P. Bellport, on February 1, was appointed Chief Engineer, advancing from Associate Chief Engineer, a position he held since 1959. Mr. Bellport succeeded Grant Bloodgood.

Chief Engineer Bellport was Regional Director at Sacramento, Calif., from 1957 to 1959, when he moved to Denver and worked with Mr. Bloodgood. (See story on page 44.)

Mr. Bellport was born May 25, 1907, at La Crosse, Kans. He was graduated from Polytechnic College of Engineering in Oakland, Calif., in 1927 with a degree in engineering. His first Bureau of Reclamation service was in 1936 on the Contra Costa Canal of the Central Valley project in California.

He subsequently worked on many other features of the Central Valley project and directed construction of the Tracy pumping plant. He was later Resident Engineer for the Solano project in California, including Monticello Dam and the development and construction of the Tracy fish facility.

He is a member of the American Society of Civil Engineers, the U.S. Committee on Large Dams, and is a registered professional engineer in Colorado. # # #

Parmakian Named Associate Chief Engineer

John Parmakian in March was named Associate Chief Engineer to work with Chief Engineer Bellport at Denver. He formerly served as Assistant Chief Designing Engineer (Civil and Structural) from 1961 to the time of this appointment, and also held the position of Chief of the Technical Engineering Analysis Branch at Denver.

Mr. Parmakian's professional career with the Bureau began in 1930 when he was a junior engineer assigned to testing hydraulic structures at Hoover Dam. He is author of numerous technical articles and a book, *Waterhammer Analysis;* a director of the American Society of Mechanical Engineers; and is affiliated with various other engineering asociations.

Mr. Parmakian is a graduate of Massachusetts Institute of Technology and received his master's degree from the University of Colorado. # # #

G. E. Burnett Is Promoted To Chief Research Scientist

Promotion of Graydon E. Burnett to Chief Research Scientist, filling the vacancy left by his predecessor, Walter Price, who retired a few months ago, was announced February 12. Mr. Burnett will serve with new Chief Engineer B. P. Bellport who took office February 1.

Mr. Burnett has been Acting Chief Research Engineer since early 1962.

A native of Madison, So. Dak., Mr. Burnett holds a B.S. degree in chemistry from the University of Utah, where he graduated with honors and was elected to membership in the honorary scholastic fraternity, Phi Kappa Phi. He is a member of Sigma Xi, an honorary scientific society and is a registered professional engineer in the State of Colorado.

Mr. Burnett is a career employee of the Bureau and has served continuously with the Bureau since 1936, with the exception of war service from 1942 to 1946 when he trained troops in chemical warfare. # # #

Robert J. Pafford Jr. Directs Region Two

A man who had a hand in developing a well-known cooperative, multipurpose water-resource plan affecting all or part of 10 Midwestern States reported last Decemmer to head Bureau programs in Region 2. He is Robert J. Pafford Jr., new Regional Director who succeeds to the position left by H. P. (Pat) Dugan who, a few weeks earlier, was moved to Denver to be Director of Region 7.

The water-resource plan referred to above is the Pick-Sloan plan which was named after Gen. Lewis A. Pick and Glen Sloan, then Regional Director of the Bureau of Reclamation. Mr. Pafford was closely associated with General Pick in developing the Army Corps of Engineers' phases of the plan for the U.S. Army Corps of Engineers in the middle and late 1940's. It was in 1942 when Mr. Pafford, a native of Salina, Kans., joined the Corps of Engineers, Omaha Division.

He was choosen "1955 Federal Employee of the Year" in the Nebraska area.

Mr. Pafford is a long-term career employee of the Federal Government and holds a degree in electrical engineering from Kansas State University at Manhattan. He first joined the Corps in 1934 as a junior electrical engineer, then moved into hydraulic engineering positions on Corps projects in West Virginia and in the Missouri River Basin.

From 1957 until his appointment to the Reclamation headquarters at Sacramento, Calif., Mr. Pafford held the position of Supervisory Civil Engineer with the Corps' Missouri River Division in Omaha, Nebr.

Mr. Pafford is a member of the American Association for Advancement of Science, American Society of Civil Engineers, International Association for Hydraulic Research, Omaha Engineers Club, U.S. Committee of the International Commission on Large Dams, and the U.S. Committee of the International Commission on Irrigation and Drainage. # # #

D. R. Burnett to Head Philippine Office

Donald R. Burnett, who for nearly 4 years has been Chief, Division of Project Development, left his Washington post on April 5 to become Project Engineer in charge of a new Bureau office at Manila in the Philippines. Function of the new office is to work with Philippine officials in carrying out investigations of multiple-purpose development of the major river basins of the islands under auspices of the Agency for International Development.

Mr. Burnett first came with the Bureau at Boulder City, Nev., March 1934. With step-by-step increases in Bureau responsibilities, he also served at Denver and at various other locations. In 1946, he was appointed Region 5 Program Control Officer, Region Planning Engineer in 1952, and Assistant Region 5 Director in 1956, holding the latter until July 19, 1959, when he was assigned to Washington, D.C.

In 1931, Mr. Burnett was awarded his B.S. degree in engineering from the University of Utah at Salt Lake City, Utah. While in the Army Air Force from 1941 to 1946, he served in the European and Japanese theaters, attaining the rank of lieutenant colonel. # # #

WATER REPORT

by *HOMER J. STOCKWELL*
Water Supply Forecasting Unit
Soil Conservation Service
Portland, Oreg.

For many irrigated areas of western United States the water supply outlook for 1963 is as dependent on water stored in reservoirs as that stored in the snowpack for runoff next summer. As of mid-March, the mountain snowpack in the Cascades of Washington and Oregon, the Sierras of California, and in the mountains of southern Idaho was at or near a minimum of record. The normal snow accumulation has also been much less than average in eastern Oregon, Utah, Nevada, and Arizona. Only along the Continental Divide of the Rockies has the snowpack to date approached average.

Storage in reservoirs carried over from the relatively plentiful water year of 1962 is the principal factor that differentiates a fair water supply outlook for 1963 from an exteme shortage.

With a substantial dependence on storage, water users should consider the effects of a depletion of storage at the end of the season on the outlook for 1964. Water should be carefully utilized. Should the snow accumulation next season be average or less, a widespread and severe water shortage will be likely in 1964.

The following is a more detailed report by States.

Arizona

The 1963 water supply outlook for Arizona is near average for the major irrigation projects. Storage in San Carlos and Salt River project reservoirs showed a substantial improvement in recent months, adding to an already favorable storage situation. Winter streamflow has been far in excess of average. Streamflow during the spring months will range near 50 percent of average for all streams except the Upper Gila where near average flows are in prospect. March precipitation has been slightly less than average except for the Upper Gila where near average rainfall has occurred. Soils in the high elevation snow areas are in saturated condition. The water supply outlook along the Little Colorado and Verde rivers is not as favorable.

California

The California Department of Water Resources, coordinating agency for snow surveys and water supply forecasting in California, reports that, as of mid-March, water supply conditions during the spring and summer season this year will be seriously short in many areas of California.

In the vital Central Valley area this year, snowpack accumulation ranges from near zero on the Feather and Yuba River basins in the Sacramento Valley area to a high of only 65 percent of normal on the Kern River basin in the San Joaquin Valley. The Owens River watershed on the east side of the Sierras in the Lahontan area was the only major basin in the State with normal snowpack in mid-March.

The South Coastal and Colorado desert areas are the only major hydrologic areas in which below normal runoff conditions exist; runoff in both of these areas was considerably below normal for both February and the season to date.

The excessive February runoff resulted in a gain in reservoir storage throughout California. Total water in storage at month's end amounted to 111 percent of the average.

With Lake Mead 83 percent of capacity, the major agricultural areas of California that have access to these supplies should experience no problem during the coming season.

Colorado

With near-average streamflow in prospect, water supply outlook for the South Platte and its tributaries is good. Storage in smaller irrigation reservoirs in the tributary stream irrigated area is above average. On the lower South Platte, storage is near capacity. The resources of the Colorado-Big Thompson project will be fully available to supplement streamflow. Storage in municipal reservoirs is above average.

For the west slope streamflow will be near three-quarters of average, but water supplies will be adequate throughout the season for the Upper Colorado River tributaries.

The flow of the Rio Grande through San Luis Valley will again be much less than average. Extensive use of groundwater will again be required. The Arkansas Valley will be adversely affected by both shortage of stored water and about 75 percent of average streamflow.

Idaho

Snowfall throughout Idaho has been one of the lowest years of record during the 1963 season. Fall rains preceding the snow in 1962 were also below normal. This combination indicates critically low streamflow during the irrigation season.

Carryover storage on the main stem of the Snake, Boise, and Payette Rivers is excellent, but will make up only part of the deficiency in streamflow for 1963. On the many smaller rivers and streams in Idaho, without adequate reservoirs, a critical water shortage is in prospect.

Montana

Streamflows are forecast at slightly less than average for the 1963 season. Irrigation water supplies are reasonably assured for the areas along the larger streams east of the Divide. Snow cover has been light on the headwaters of the Beaverhead tributary to the Jefferson where late season shortages are a definite prospect. Lack of seasonal snowfall and carryover storage will limit water supplies along the Marias and Milk Rivers in north-central Montana and on Red Rock Creek, tributary to the Yellowstone.

Streamflow during the snowmelt season is forecast at about three-quarters of average in western Montana. Storage in power reservoirs is near average; they are expected to fill during the snow runoff period.

Nevada

April–July streamflow forecasts indicate that runoff will be much below average, all less than one-half of average. In aggregate, storage in all principal reservoirs in Nevada except Lake Tahoe is well above average for April 1. Water users served from these reservoirs should have a moderately adequate irrigation season water supply. Nevada water users without reservoir facilities will have an extremely poor water supply this coming spring and summer.

New Mexico

Seasonal snowfall has been near average in northern New Mexico. The flow of the Rio Grande at Otowi Bridge for the middle Rio Grande district is expected to be slightly less than for the 1943–57 average and similar to the 3 years before 1962. In the lower Rio Grande, inflow to Elephant Butte will be less than average and also typical of recent years. Total surface water supplies will continue to be substantially less than demands.

Oregon

The 1963 irrigation water outlook for Oregon is extremely poor except for those areas which have adequate stored water supplies. Snowpack in mountain areas, except for the northeast section of the State, is the lowest of record for mid-March. While winter streamflow has been high, summer flows from snowmelt will be near a minimum of record.

The most favorable part of the water outlook is the relative adequacy of storage. In 23 major reservoirs, storage is 105 percent of average for this date. Not all irrigated areas have adequate storage to eliminate the probability of late-season shortages. Among these areas are lands served by Agency Valley and Warm Springs Reservoirs in Malheur County and McKay Reservoir in Umatilla County.

South Dakota

Storage in reservoirs serving the Black Hills area is almost two times the 1943–57 average. With an average snow cover in the mountains, the irrigation water supply outlook for this area is good.

Utah

The water supply outlook for all streams in the Great Basin area of Utah is poor to extremely poor. Most forecasts range between 20 percent and 55 percent of average for these rivers. The best prospects are for the Provo and Logan Rivers which are forecast to flow 63 and 56 percent of average, respectively. The Sevier at Kingston is forecast at only 13 percent of normal. Low reservoir storage complicates the problem for water users on the Sevier and Beaver Rivers in southern Utah, and those served by Utah Lake and Strawberry Reservoirs. The general outlook is comparable to 1961.

The outlook is poor for the Colorado and Green River tributaries.

The water supply for lands along the Virgin River is forecast at less than that available in 1961.

Washington

Forecasts of streamflow in Washington are much below average for 1963 including that of the Columbia River through the State. Snow surveys on March 1 indicated a snow water content ranging from only 19 percent of average in the Cascades up to about half of average in a few other areas.

For the large irrigated area served by the Yakima River, the outlook is fair. Snowmelt season streamflow is expected to be only one-third of average, but storage in reservoirs should make up most of the deficiency unless summer demands are excessive.

Wyoming

Water supply outlook improved on the headwaters of the Wind and Shoshone Rivers in late winter. The outlook for below-average streamflow for the snowmelt season remains. There is still some possibility of shortages in late-season water supply for some smaller tributaries from the Continental Divide range west of the Powell Basin. Storage is limited in this area, and shortages may occur in late season if drought conditions prevail during the summer months.

With carryover storage at near-average levels on the North Platte and Laramie Rivers, the outlook is good for irrigation water supplies along these streams. With average snowfall for the spring months, no shortages are in prospect for this watershed. # # #

Information for this report for RECLAMATION ERA was provided by Snow Survey Supervisors of the Soil Conservation Service and their cooperators for all States, except California, which was provided by the Department of Water Resources. Material was assembled under the direction of R. A. Work, Head, Water Supply Forecasting Unit, Soil Conservation Service.

MAJOR RECENT CONTRACT AWARDS

Specification No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DS-5849	Missouri River Basin, Mont.-Wyo.	Jan. 14	2 125-ton traveling cranes and 1 lifting beam for Yellowtail powerplant.	Star Iron & Steel Co. Tacoma, Wash.	$180,975
DS-5860	Colorado River Storage, Arizona-Utah.	Jan. 3	47 23-kv, 10 230-kv, and 13 345-kv disconnecting switches for Glen Canyon switchyard, Schedule 2.	Schwager-Wood Co., Inc. Portland, Oreg.	145,288
DC-5861	Missouri River Basin, S. Dak.	Jan. 2	Construction of 14 miles of Fort Thompson-Big Bend 230-kv transmission lines Nos. 1 and 2.	Main Electric, Inc., and Aloysius D. Hagenstein, Minot, N. Dak.	629,484
DC-5862	Central Valley, Calif.	Jan. 11	Construction of earthwork and structures for pre-consolidation of San Luis canal, Sta. 2344+80 to 3131+90.	Eugene Luhr & Co. and Elmer G. Wendt, Inc., Rio Vista, Calif.	997,183
DC-5863	Canadian River, Tex.	Jan. 3	Construction of earthwork and structures for 56 miles of concrete pipeline for main aqueduct, Sta. 1+70 to 2976+00.	R. H. Fulton, Lubbock, Tex.	11,927,550
DC-5865	Weber Basin, Utah.	Jan. 15	Construction of earthwork and structures for Layton canal, Sta. 136+50 to 586+00; and relocation of Wilson canal.	Wheelwright Construction Co., Ogden, Utah.	798,401
DC-5867	Colorado River Storage Colorado.	Jan. 25	Construction of Curecanti substation, stage 01.	Wismer & Becker, Sacramento, Calif.	1,164,000
DC-5869	Missouri River Basin, Iowa.	Jan. 16	Construction of stage 02 additions to Denison substation.	Elliott Construction Co., Omaha, Nebr.	143,900
DC-5870	Columbia Basin, Wash.	Feb. 5	Construction of earthwork, concrete lining, and structures for Eltopia Branch canal, Sta. 850+50 to 1338+50.70; and Block 17 laterals, wasteways, and drain, Eltopia Branch canal laterals, utilizing concrete lining in laterals EB15 and EB24, Schedule 1.	Sime Dredging Co., and A & B Construction Co., Kennewick, Wash.	1,292,259
DC-5871	Lower Rio Grande Rehabilitation, Texas	Jan. 24	Clearing, and construction of earthwork and structures for rehabilitation of Mercedes 23 drain and control structure (IBWC structure No. 170A).	H. and H. Concrete Construction Co. and K. F. Hunt Contractor, Inc., Corpus Christi, Tex.	120,351
DC-5872	Missouri River Basin, Nebr.	Jan. 25	Construction of 14 miles of concrete-lined Ainsworth canal, Sta. 1177+70 to 1914+50. Section 3.	Missouri Valley Construction Co., Grand Island, Nebr.	1,702,428
DC-5873	do	Feb. 15	Construction of additions and modifications to Gering substation.	C. S. P. Engineering Co. & Electric Service Co., Casper, Wyo.	282,500
DC-5874	do	Feb. 25	Construction of 12 miles of Red Willow canal, Sta. 476+50 to 1276+20; 10.7 miles of laterals, and 7.8 miles of drains.	Bushman Construction Co., St. Joseph, Mo.	1,144,566
DC-5880	Missouri River Basin, Mont.	Feb. 21	Constuction of stage 03 additions to Dawson County substation.	Electrical Builders, Inc., Valley City N. Dak.	191,800
DC-5884	Missouri River Basin, S. Dak.	Feb. 26	Construction of stage 02A, 02B, and 03 additions to Fort Thompson substation.	Ets-Hokin & Galvan, Inc., Denver, Colo.	535,000
DC-5885	Colorado River Storage, Colorado.	Mar. 7	Construction of Hayden substation, stage 01	Wismer & Becker, Sacramento, Calif.	1,571,000
DC-5886	Missouri River Basin, Nebr.	Mar. 15	Construction of 13.6 miles of Farwell South canal, Sta. 4+40 to 719+95.28; 38 miles of Farwell South laterals S-1.1 to S-12.8, sublaterals, wasteways, drains, and 5 small pumping plants.	Bushman Construction Co., St. Joseph, Mo.	1,931,466
DS-5889	Canadian River, Tex.	Mar. 18	20 horizontal centrifugal pumps for Canadian River pumping plants Nos. 1, 2, 3, and 4.	Fairbanks, Morse & Co., Hydraulic and Special Projects Division, Denver, Colo.	213,913
DC-5891	Colorado River Storage, Utah-Wyoming	Mar. 13	Construction of a visitors center at Flaming Gorge Dam.	Moe McCullough Construction Co., Salt Lake City, Utah.	106,338
DC-5892	Missouri River Basin, Basin, Mont.	Mar. 22	Construction of 12 miles asphalt membrane-lined and 25 miles of unlined East Bench canal, Sta. 2038+00 to 2550+00 (end), East Bench laterals 36.3 to 41.2, wasteways, and drains, utilizing precast-concrete pipe for the 66-inch siphon barrels, Parts A and C.	A & B Construction Co. and Sime Construction Co., Helena, Mont.	1,731,366
300C-176	Colorado River Front Work and Levee System, California.	Feb. 28	Constructing and surfacing 6 miles of haul roads and quarrying and placing rock for bank protection structures A3, A4, A5, and A6.	H & M Construction Co., El Cajon, Calif.	224,646
300S-177	do	Feb. 4	1 12-inch hydraulic dredge to excavate settling basin between Imperial and Laguna Dams.	Ellicott Machine Corp., Baltimore, Md.	178,367
300C-178	do	Feb. 28	Quarrying, hauling, and placing rock for bank protection structures and 3 miles of haul roads.	Wennermark Co. and Ralph B. Slaughter, Redlands, Calif.	189,624
304S-142	Parker-Davis, Ariz.	Mar. 7	One 30,000/40,000/future 50,000-kva auto-transformer for Amargosa substation.	General Electric Co., Phoenix, Ariz.	113,897
400C-220	Weber Basin, Utah	Jan. 24	Drilling and casing South Weber well No. 2, and construction of pumping plants for South Weber wells Nos. 1 and 2 and Clearfield well No. 2.	Skyline Electric Co., Salt Lake City, Utah.	374,811
500S-127	Lower Rio Grande Rehabilitation, Tex.	Jan. 14	Reinforced and unreinforced concrete pressure pipe and concrete culvert pipe for Mercedes division.	Brown Supply Co., Inc., Lubbock, Tex.	519,210
701C-573	Missouri River Basin, Kans.	Mar. 5	Construction of 8.1 miles of earth lining in existing reaches of Kirwin Main and Kirwin North canals, Schedules 1 and 2.	Wentz Construction Co., Inc., Concordia, Kans.	142,879

U. S. GOVERNMENT PRINTING OFFICE: 1963 O - 679768

Major Construction and Materials for Which Bids Will Be Requested Through May 1963*

Project	Description of work or material
Central Valley, Calif.	Earthwork and structures for about 22 miles of concrete-lined canal with a bottom width of 85 ft. Canal to be lined with 4.5-in. unreinforced concrete, height of lining 28 ft. San Luis Canal, Reach No. 2, near Los Banos.
Do	First-stage construction for a 13,100-cfs pumping plant. Work will consist of earthwork; discharge lines; and constructing a reinforced-concrete plant structure, a superstructure with a structural-steel frame, an intake structure, and a discharge structure. Mile 18 Pumping Plant, about 9 miles south of Los Banos.
Central Valley and Colorado River Storage projects, California and Colorado.	Eight 156-in. butterfly valves for San Luis pumping-generating plant; and two 156-in. butterfly valves for Blue Mesa powerplant. Estimated weight: 1,870,000 lb.
Chief Joseph Dam, Wash.	Constructing about 16 miles of pipelines including 3 reservoirs with base dimensions of 38 by 66 ft, side slopes of 1½:1, and depth of 12.5 ft, lined with 4-in.-thick unreinforced concrete; and 2 steel tanks 32 ft in diameter, one 29 ft high and the other 38 ft high. Brays Landing, near Chelan.
CRSP, Arizona	Constructing concrete foundations and erecting 4 each of 8 types of 230-kv, single-circuit, guyed and self-supporting, steel and aluminum towers. Work will also include stringing of this portion of line, ahout 8 miles, to nearest dead-end structures. Glen Canyon-Shiprock Transmission Line, near Kayenta.
CRSP, Colorado	Constructing Morrow Point Dam, a 360,000-cu-yd thin arch structure about 465 ft high and 720 ft long, and appurtenant features, including an outlet works and spillway through the dam and a spillway stilling basin and weir at the downstream toe. Work will also include constructing an underground powerplant 57 by 235 by 120 ft high, to house two 60,000-kw generators. On the Gunnison River about 22 miles east of Montrose, Colo.
Do	Removing and constructing 138-kv wood-pole transmission lines. Work will consist of removing structures from 7.6 miles of line; constructing structures for about 11.2 miles of line; and stringing three 397.5 MCM, ACSR conductors, and two ⅜-in. steel strand overhead ground wires for about 12.9 miles of line. Vernal-Hayden-Green Mountain transmission line, in the vicinity of Hayden substation, near Mount Harris.
Do	Constructing a steel frame, metal panel, glass, and brick masonry wall building with a full basement, full ground floor, and partial second floor. The building will have about 33,500 sq ft of floor area and will house a dispatching center as well as administrative offices. At Montrose.
CRSP, Colorado and Wyoming.	Furnishing and installing fence gates; clearing right-of-way; constructing concrete footings; and furnishing and erecting steel towers for about 140 miles of 230-kv, single-circuit Hayden-Archer (Cheyenne) transmission line; and furnishing and stringing three 1,272 MCM, 45/7, ACSR conductors and 2 ⅜-in., high-strength, steel strand, overhead ground wires. From Hayden, Colo., to Cheyenne, Wyo.
Columbia Basin, Wash.	8 vertical-shaft, single-stage, turbine-type centrifugal pumping units each rated 10,000 gpm at a total head of 95 ft driven by 880-rpm, 300-hp, submersible electric motors. Grand Coulee powerplant.
Emery County, Utah	Constructing Joes Valley Dam, a 1,240,000-cu-yd earthfill structure about 195 ft high and 740 ft long, including a spillway and diversion works consisting of a concrete-lined tunnel with a morning glory inlet and stilling basin and a conduit-type outlet works. On Cottonwood Creek about 46 miles by road southwest of Price.
Gila, Ariz.	Constructing about 4.5 miles of 4-ft bottom width concrete-lined canal and about 5 miles of 30- to 48-in.-diameter cast-in-place or precast-concrete pipe laterals. South Gila, Unit 2, near Yuma.
Hungry Horse, Mont.	Constructing a 77- by 26-ft 1-story, steel-frame building with reinforced-concrete foundations and floor slab, stone veneer walls, and a steel roof deck. Work will also include excavation for parking area, constructing a steel frame viewpoint shelter, concrete curbs, walks, and a flagpole. About 9 miles southeast of Columbia Falls, Mont.
MRBP, Montana	Furnishing and stringing 3 954 MCM, 45/7, ACSR conductors and 2½-in. high-strength, steel strand, overhead ground wires for 160 miles of 230-kv, single-circuit, steel-tower Dawson County-Custer transmission line.
MRBP, Nebraska	Constructing about 65 miles of laterals with bottom widths varying from 30 to 3 ft, about 35 miles of which will be earth lined, and about 5 miles of drains with bottom widths varying from 22 to 7 ft. Ainsworth Laterals, near Ainsworth.
MRBP, Nebraska and Wyoming.	Furnishing and installing fence gates; clearing right-of-way; constructing concrete footings; and furnishing and erecting steel towers for about 75 miles of 230-kv, single circuit Stegall-Archer (Cheyenne) transmission line; and furnishing and stringing 3 1,272 MCM, 45/7, ACSR conductors and 2 ⅜-in., high-strength, steel strand, overhead ground wires. From Gering, Nebr., to Cheyenne, Wyo.
MRBP, South Dakota	Additions to the Philip Substation (Stages 02 and 03) will consist of constructing concrete foundations and a 38- by 48-ft concrete masonry service building; furnishing and erecting steel structures; furnishing and installing 1 15,000-kva, 115/69-kv autotransformer, 4 115-kv and 1 69-kv circuit breakers and associated electrical equipment; and grading and fencing the addition.
Do	Furnishing and installing fence gates; clearing right-of-way; constructing concrete footings; and furnishing and erecting steel towers for about 310 miles of 230-kv, single-circuit Oahe-New Underwood-Stegall transmission line.
Norman, Okla.	Constructing about 30 miles of 18- to 36-in.-diameter pipelines of concrete pressure pipe, pretensioned concrete cylinder pipe, mortar-lined and coated steel pipe, or noncylinder prestressed concrete pipe. Near Norman.
Do	Constructing the reservoir pumping plant, an indoor-type, reinforced-concrete pumping plant, about 90 ft long, 35 ft wide, and 70 ft from base to motor floor; constructing a 17-ft-wide and 60-ft-long, reinforced-concrete decked steel bridge; and constructing relift pumping plant, an indoor-type, flat-slab, reinforced-concrete structure, about 87 by 38 ft. Near Norman.
Seedskadee, Wyo.	Furnishing, installing, and testing 1 vertical-shaft, 10,000-kw, 150-rpm, 0.9-pf, 4,160-volt generator with direct-connected exciter for Fontenelle powerplant.
Weber Basin, Utah	Constructing Lost Creek Dam, a 2,000,000-cu-yd earthfill structure about 190 ft high and 1,100 ft long, including a chute-type spillway on the right abutment and a tunnel outlet works with an access shaft and elevator. On Lost Creek about 12 miles northeast of Devils Slide.
The Dalles, Oreg.	Constructing about 42 miles of pipelines including 2 reservoirs with base dimensions of 25 by 70 ft and 30 by 70 ft each lined with 4-in. reinforced concrete; 5 steel tanks 13 to 26 ft in diameter and 28 to 51 ft high; 1 elevated steel tank of 185,500-gallon capacity; 1 indoor-type pumping plant 112 by 32 ft with 5 horizontal, centrifugal pumps; 1 outdoor-type pumping plant 88 by 32 ft with 5 horizontal centrifugal pumps; and 5 small outdoor-type pumping plants. Near The Dalles.

*Subject to change.

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington 25, D.C. Use of funds for printing this publication has been approved by the Director of the Bureau of the Budget, January 31, 1961.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price 15 cents (single copy). Subscription price: 50 cents per year; 25 cents additional for foreign mailing.

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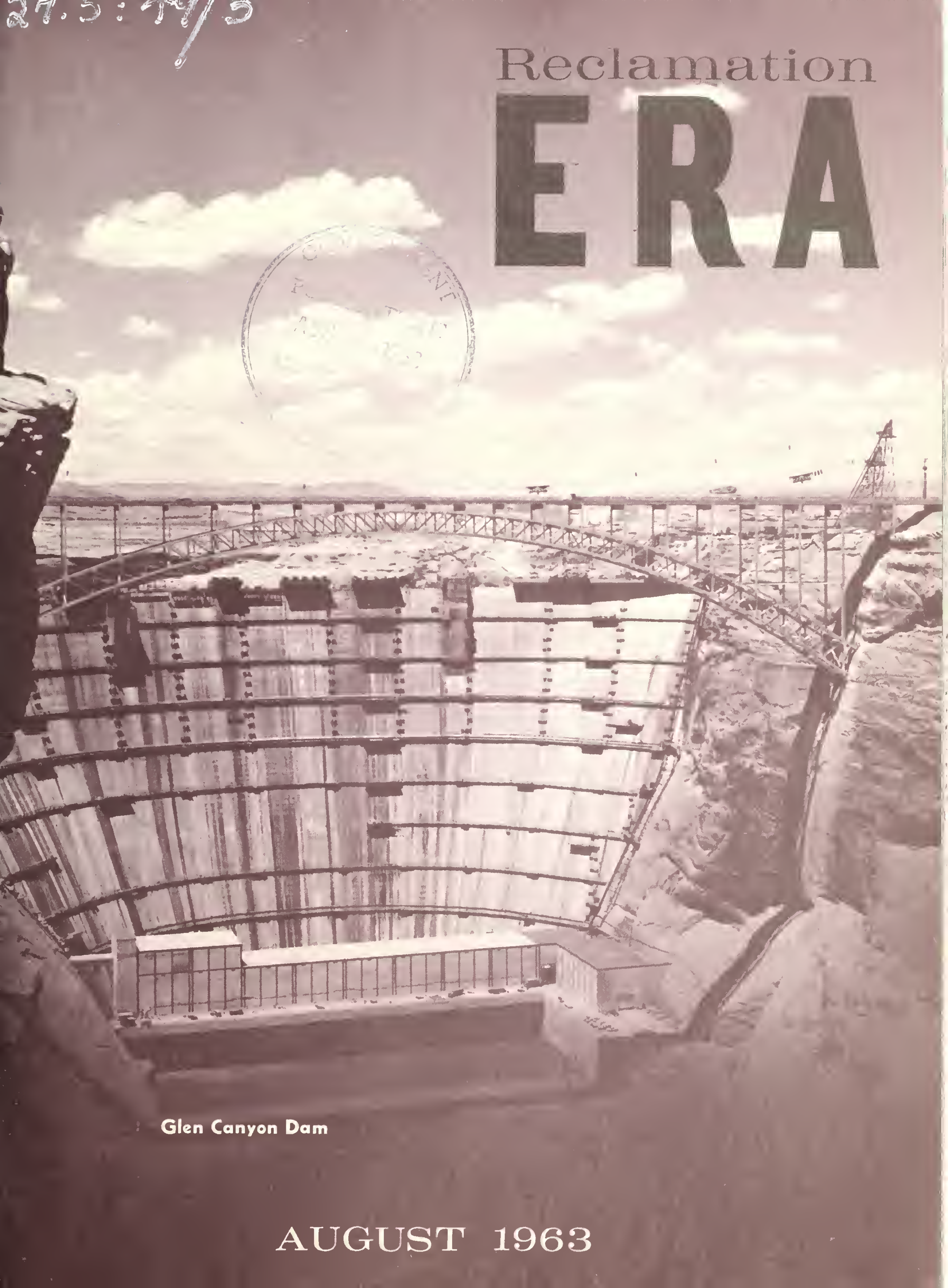
Reclamation ERA



Glen Canyon Dam

AUGUST 1963

Reclamation

ERA

AUGUST 1963 Volume 49, No. 3

Contents . . .

OTTIS PETERSON, Assistant to the Commissioner—Information
GORDON J. FORSYTH, Editor
KATHRYNE C. DIMMITT, Art Editor

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington 25, D.C. Use of funds for printing this publication has been approved by the Director of the Bureau of the Budget, January 31, 1961.

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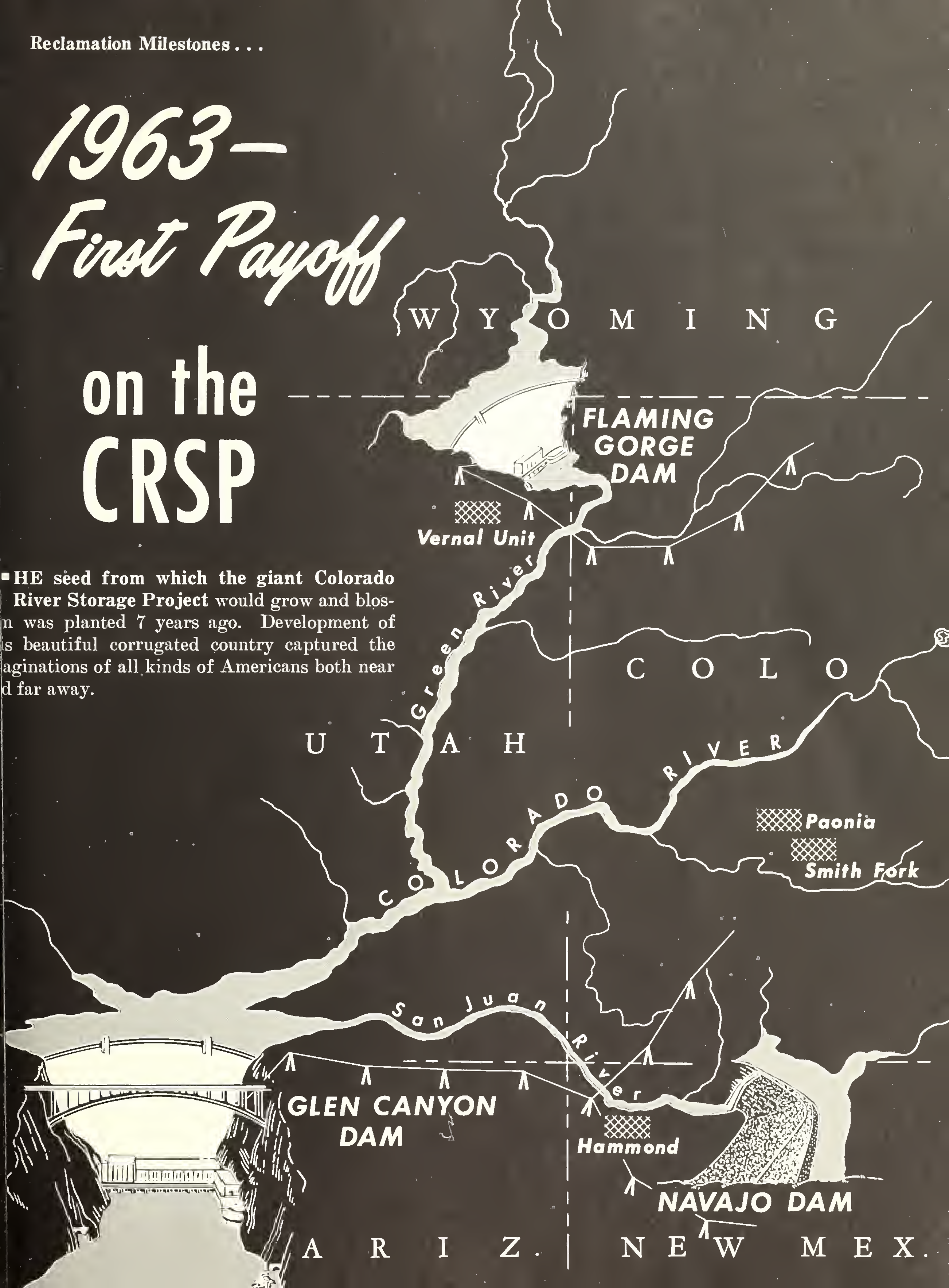
1963— First Payoff on the CRSP

HE seed from which the giant Colorado River Storage Project would grow and blos-
n was planted 7 years ago. Development of
s beautiful corrugated country captured the
aginations of all kinds of Americans both near
d far away.



Men's eyes sparkled at the thoughts—irrigation of fertile virgin lands, electricity for new and existing enterprises, desilting, recreation in astonishing scenery, tourist potential to scenic wonders rarely yet beheld, and employment opportunities—all from water not now being used in the Upper Colorado River Basin and most of it wasting away to the sea.

In 1956, the Congress passed the authorizing legislation. The grand plan for development of the Upper Colorado River Basin water was set in motion.

Now in 1963, the reaping of the first harvest of benefits are beginning. And in the coming years, the benefits will grow in magnitude to equal or exceed the hopes and dreams of the most optimistic Upper Basin proponents.

The first CRSP hydroelectric power will go on the line from the Flaming Gorge Powerplant. Boaters are flocking to reservoirs which have formed behind the storage unit dams—Lake Powell (Glen Canyon Reservoir) on the Colorado River, Flaming Gorge Reservoir on the Green, and Navajo Lake on the San Juan.

This year water will be delivered for irrig tion use on four completed participating Feder Reclamation projects with about 7,500 acres new land and 36,000 acres of supplemental lan

In the coming years, the trickle of 1963 benefi will swell to a torrent.

Growth in irrigation agriculture in the Bas will lay the cornerstone for stable growth in t intermountain west.

Livestock production centers on coordinati the use of the grazing lands of the high mou tain fringes of the Upper Basin and of the bro dryland plateaus with the livestock feed base pr duced on the irrigated lands. With expansion the irrigated lands, the livestock industry also c expand—to the benefit of the entire Natio Other crops raised will be deciduous fruits, sug beets, and other cash crops not in surplus.

But equally important is that stable irrigati agriculture provides the core on which a mo complex commercial and industrial developme will be built. In the process of diversified ec nomic growth, the participating projects and oth non-Government development and use of Upp

Left—A stockman-irrigator looks out over the valley of the Pine Riv

Below—Sheep on irrigated pasture are common in the CRSP.

Basin water will supply large quantities of water for municipal and industrial uses.

Power For Regional Growth

Electric power needs will increase by leaps and bounds, as the economy of the intermountain west expands and diversifies. A small part of this demand will be met by the hydroelectric power to be produced at the CRSP dams and powerplants. From 1963 to 1967, most of the 1,300,000 kilowatts of CRSP installed capacity will be fed into the Interconnected Transmission System. This system will be made up of about 2,000 miles of CRSP transmission lines (about 1,300 miles are now completed or under construction), which will tie into 4,700 miles of adjacent Federal system lines and interconnect with more than 7,200 miles of preference user and private utility lines.

CRSP power output will go to more than 200 qualified preference user organizations, as required by Federal Reclamation law, throughout the marketing area covering the intermountain west. The full production of CRSP power will be taken by the preference users as rapidly as it comes on the line. But CRSP power will help only to meet preference user load growths.

Looking ahead to 1980, the total installed capacity needed to meet all the anticipated electric

Pastures are irrigated on the now completed Hammond project.

Cattle being moved along in an irrigated pasture.

HOW'S THE VIEW FROM UP THERE?

Workmen clipping-in on a conductor line.

Reservoir behind Green Mountain Dam in background.

power needs in the intermountain west will approach 20 million kilowatts. At the present time, there are only about 5 million kilowatts of installed capacity in all existing generating plants. The authorized CRSP powerplants will add only 1,300,000 kilowatts of capacity. Thus, non-Federal organizations will have to build much more generation capacity than they now have if the pyramiding power needs of the intermountain area are to be met in the next 10 to 15 years.

Recreation Benefits a Bonus

Recreation development on the new CRSP lakes will provide unexcelled opportunities and benefits to the region and the Nation. Lake Powell is now rising—creeping up the face of Glen Canyon Dam and lengthening up the deep and winding Glen Canyon to lap on spectacular rust-red to blazing-red canyon walls. The 27 million acre-foot lake will be 186 miles long. Its surface area will equal that of Lake Mead. But it is long and narrow with hundreds of side canyons awaiting exploration. Boaters will always find Lake Powell a fascinating, scenic area for exploration.

In 1963, 8 million game fish were planted in Lake Powell with fishing scheduled to begin in 1964.

Lake Powell is administered by the National Park Service as the Glen Canyon National Recreation Area. To serve the public while the lake is filling, temporary boat ramps and related facilities are already developed at Wahweap near Glen Canyon Dam. Nine sites will be fully developed over a period of years to assure complete public access to Lake Powell.

Floating docks and other facilities are being installed in the Bridge Creek arm of Lake Powell to serve the thousands who will come by boat to visit the heretofore nearly inaccessible Rainbow Bridge National Monument—home of the world's largest natural bridge.

At the Flaming Gorge and Navajo Reservoirs, the National Park Service, working with the Bureau of Reclamation, U.S. Fish and Wildlife Service, and appropriate State and local agencies, is similarly developing recreational sites. Fish are being planted, boat ramps built, picnic and camping grounds provided.

On the participating projects where smaller storage reservoirs are built, appropriate recreational

facilities are planned by the National Park Service and the basic needs for boating, fishing, etc., provided. These smaller reservoirs add to the total recreational opportunities, and all will be well patronized by thousands of people each year. Examples to date are the Steinaker, Paonia, and Crawford Reservoirs on the Vernal Unit, Central Utah Project, and the Paonia Project and the Smith Fork Project in Colorado, respectively. On these smaller reservoirs, recreational activity is administered by Federal, State, or local public agencies.

Upper Basin Growth Assured

Benefits from the CRSP arriving in 1963 are just a beginning. The Upper Basin is assured of steady, stable, rapid growth, but not booming growth with all the problems that inevitably occur. The key to the future of the Upper Basin is the control and use of the waters of the Colorado River. What has been the course of events in the intervening years, and where do we now stand?

Construction of the authorized storage units of the CRSP was first in order of importance. The job was tackled immediately. Glen Canyon Dam was started with award of the prime construction contract in April 1957. Contracts for Flaming Gorge and Navajo Dams were awarded in June 1958. And in 1962 work was started on the Curecanti Storage Unit with contracting for Blue Mesa Dam, the first of three dams in that unit. This year, construction of Morrow Point Dam, the second of the three dams, was gotten underway.

CRSP Storage Units have prime importance in the basinwide program. They assure regulation of the Upper Colorado River system. The nearly 35 million acre-feet of storage they provide will assure that the Lower Colorado River Basin states will receive their share of Colorado River water every year. Because of this, extensive diversions for consumptive uses of water throughout the Upper Basin states can be made. Development of the long list of participating projects can proceed without endangering the rights of the Lower Basin to its share of water under the Colorado River Compact of 1922.

Without the Storage Units and the carryover or holdover storage they will capture in wet years, Upper Basin prospects would not be feasible. In

Continued on page 70

Top—**Water emerging from left diversion tunnel, Glen Canyon Unit.** ***Center***—**Fishing this year in emerald-green waters below Glen Canyon Dam.** ***Right***—**Jim Butler displays trout.**

RECLAMATION

Technical Leadership-3

Taking the PUNCH out of water

"IT'S water under the bridge" or "It's water over the dam" are expressions meaning, *Of course, it's too late now*, but that is not our story.

When a Bureau of Reclamation engineer, however, says "It's water over the dam," he means *furious torrents of water pouring by the ton down dam spillways bound for destruction below.* This is the PUNCH in water works that must be taken out to quiet the turbulence that would otherwise undermine the foundation at the toe of dams.

What have engineers done to tame the surge of more than 2 million gallons of water that will flow every second through the tunnel spillways at Glen Canyon Dam in Arizona, or take the destruction out of the energetic 1 million gallons plumeting out of the tunnel spillway at Yellowtail Dam in Montana?

RECLAMATION COMMISSIONER FLOYD E. DOMINY introduced this series in the February 1963 issue of the Reclamation Era with the number one article entitled, "Computers Work in Reclamation." The second one, "Being Sure About Dam Foundations," was printed in the May 1963 issue.

Below—Water spouting from spillway model represents 247,000 gallons a second.

he "ski-jump" or flip bucket model of the ase of the overflow spillway at Anchor am, Wyoming.

Reclamation engineers in the Bureau's Engi-eering Center at Denver have shown that taking he harmful punch out of rampaging water at lams is done by research and design. To do this, hey dissipate or disperse the enormous energy of vater falling from great heights by building into he water passages carefully contrived devices like "ski-jumps" to deflect cascading water. The ski-ump, or flip bucket, is one of the most effective of hese built-in appurtenances. The bucket directs he force of the many tons of water by flipping it nto the air and far downstream from the dam hus spreading its impact over a large area.

Reclamation's development of energy dissipat-ng and dispersing devices in water passageways epresents one of the most intensive endeavors ever undertaken in hydraulic research. La-oratory research on this development covers a eriod of more than 30 years. Through study and nalysis of hundreds of models built in the Bu-eau's hydraulics laboratory in Denver during this eriod, many dams and control structures through-out the West are capable of discharging each sec-ond millions of gallons of water safely, effectively, nd economically.

Research Models

Most flip-bucket structures are studied in the ydraulics laboratory by precisely built, small scale reproductions of the full-sized structures. As the water descends a model spillway chute or emerges at high velocity from a spillway tunnel, it is deflected by the miniature built-in bucket. Models are often built of transparent plastic so the flow can be studied visually. High-speed motion picture cameras trained on the water show its path as it is flipped upward and downstream.

A variety of instruments aids in the measurement of velocity, pressure, depth, and volume of flow. From these observations and measurements, laboratory researchers are able to analyze the flow of water in and past the bucket, make the necessary modifications to obtain the best and most economical performance, and insure competent operation of the full-sized structure.

Outstanding examples are the two spillway tunnels at Glen Canyon Dam which is nearly completed on the Colorado River. Each 41-foot-diameter tunnel is designed to discharge each second more than a million gallons of water at a velocity exceeding a hundred miles an hour. This represents the release of more than 13 million horsepower into the river.

From extensive tests of hydraulic models, a flip bucket was developed for the outlet portal of each tunnel, one on each side of the river. The flip buckets, constructed of reinforced concrete and curving upward from the floors of the tunnels to

the heights of a 2-story house, are shaped to throw the water in controlled patterns onto the river. Thus, as the flow rushes out of the two tunnels, it is deflected high into the air and outward before falling far downstream from the dam where it can do no harm.

A Unique Bucket

Another example is the flip bucket at Yellowtail Dam, under construction on the Bighorn River in southeast Montana. This unique bucket, also of reinforced concrete construction, has a horizontal basin floor 130 feet long followed by an upwardly curved sill 25 feet high. At spillway flows up to 90,000 gallons a second, the water does not have sufficient energy to sweep the pool of water out of the basin. It is thus forced into a so-called "hydraulic jump"—a churning, boiling action which rapidly dissipates energy—and is then discharged quietly into the downstream channel. If the spillway discharge increases, the hydraulic jump moves downstream, and finally, at 97,000 gallons a second, the pool sweeps out of the basin and is thrown upward and downstream by the bucket. This bucket is capable of passing the maximum discharge of 1,294,000 gallons a second.

The novel design of the spillway for Morrow Point Dam also resulted from research in energy dissipation. This concrete thin-arch dam was recently placed under construction on the Gunnison River in western Colorado.

The Morrow Point spillway will consist of four rectangular openings near the top of the dam's center. Each opening, or outlet, will be controlled by a gate 15 feet wide and about 17 feet high. When all four outlets are in operation, 307,000 gallons of water a second will pour in virtually solid columns through them and fall 400 feet to a stilling pool at the toe of the dam. The designers have carefully shaped these spillway outlets. They have tipped the two center openings slightly downward; thus, the impact at the toe of the dam will be controlled and the energy will be distributed evenly. A concrete weir a short distance downstream from the dam will hold back the 60-foot deep pool. The plunging columns of water will be cushioned by the pool, and turbulence which could otherwise undermine the foundation at the toe of the dam will be avoided.

From the laboratory research in controlling flow of turbulent water, have come much valuable engineering data for designers. The performance of models and the data acquired from the laboratory investigations assure the successful operation of the Bureau's dams, large and small, and makes possible continued improvement in Reclamation water resource development. # # #

Ainsworth Seniors Tour Merritt Dam

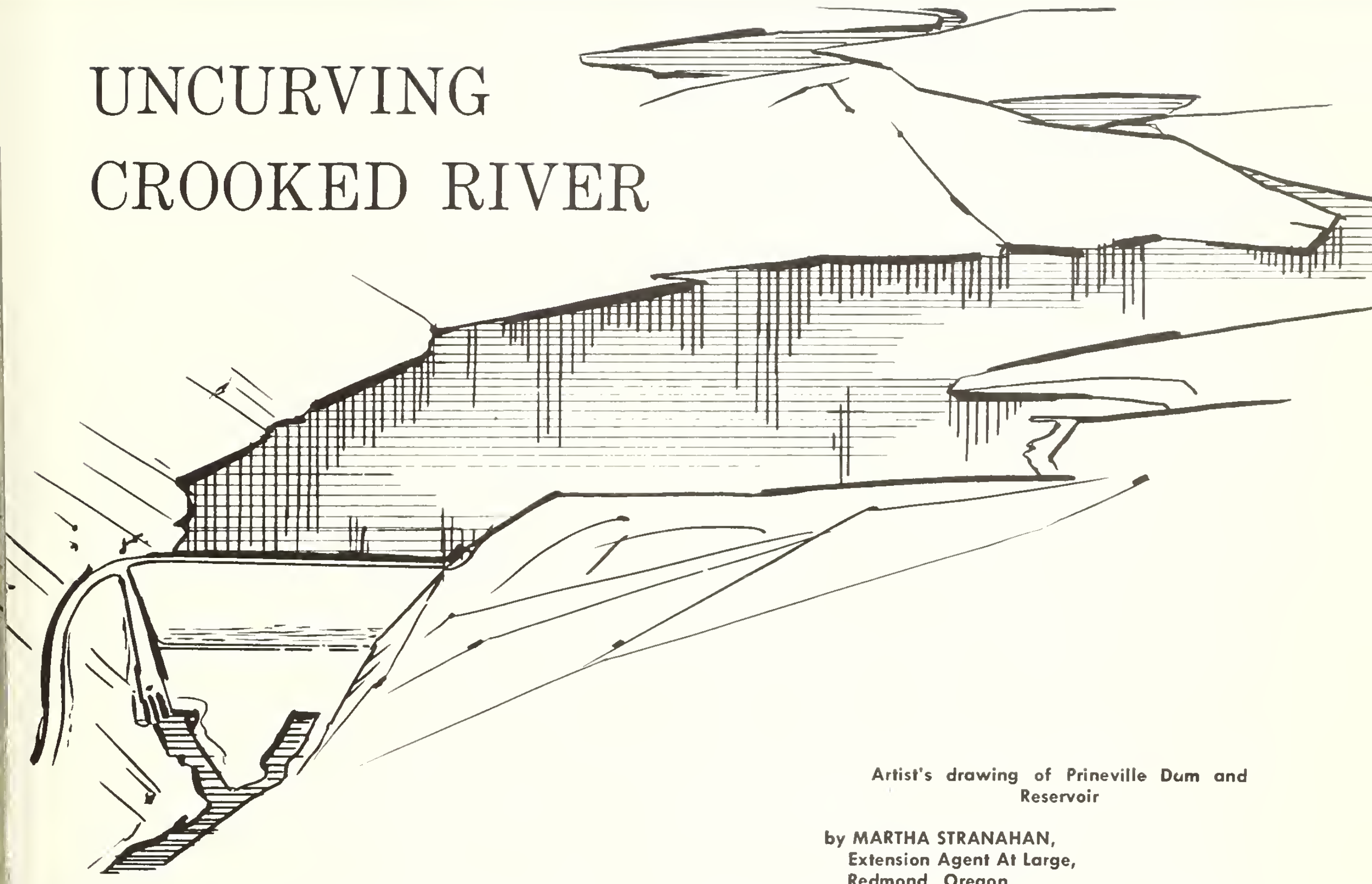
AN experiment in public relations was successfully accomplished when forty-six seniors of Nebraska's Ainsworth High School, accompanied by sponsors William S. Nelson, Herman Arent, and Mrs. Garold Miller toured Reclamation offices and Merritt Dam Project before the 1963 summer holidays.

The class assembled in the conference room of the Bureau office in Ainsworth at 9:30 a.m. where Construction Engineer, R. L. Boyce and his staff presented the history of Merritt Dam Project from the investigation stage to the appropriation of funds and the actual construction of the project. Heads of the various branches explained their primary functions and how the planning and work were coordinated to reach the ultimate goal of completing the construction of Merritt Dam, Ainsworth Canal and Laterals, and the operation and maintenance of the Irrigation District after completion of construction. Questions of the group were answered by Mr. Boyce and his staff, explaining detail of the various features.

At 11:00 a.m. the group journeyed to Valentine by school bus where they were met by Bureau of Reclamation Safety Officer, Robert D. Fitch who accompanied them to Snake River Falls for a picnic lunch. From the falls the tour continued with a visit to Merritt Dam field office and laboratory, Merritt Dam and Ainsworth Canal, and the various features of construction of the project.

The tour was a result of previous arrangements made by representatives of the senior class, Miss Anne Coleman and Miss Sheila Fernau. # # #

UNCURVING CROOKED RIVER



Artist's drawing of Prineville Dam and Reservoir

by MARTHA STRANAHAN,
Extension Agent At Large,
Redmond, Oregon

ON the Crooked River in Central Oregon, there are two interesting stories. One story is about the River's reassuring present and future, and goes like this—

With 155,000 acre-feet of water impounded in the new Prineville reservoir behind Prineville Dam on Crooked River, approximately 23,000 additional acres of Crook County farm land are assured ample water supply in years to come.

Included in the Bureau of Reclamation's Crooked River Project which was first authorized by the 84th Congress August 6, 1956, and cost in excess of $6 million, are pumping plants, conduits, drains and canals and Prineville Dam. About 20 miles southeast of the town of Prineville on Highway 27, the rockfill dam with an impervious earthcore has a 700-foot crest and rises 170 feet above the Crooked River bed in a rocky, juniper-dotted canyon.

Some distribution lines still are to be constructed, but the project essentially was completed in the spring of 1962.

It provides water for approximately 10,000 acres of new land and supplemental water for 10,200 acres of inadequately irrigated lands. Crooked River Project extension, which Congress has not yet entirely authorized, will provide for irrigation of 2,800 acres not heretofore irrigated, and put total cost over $8 million.

Orderly storing and dispensing of Crooked River's waters, which can flood in April and nearly vanish by July, should stabilize farm operations in its drainage area of 4,330 square miles, says Crook County Agent Gus Woods. The project is integrated with existing Ochoco Dam and Reservoir on Ochoco Creek.

In the spring of 1962 county farmers began turning water into new farm laterals and sending

it over fields which, after 30 years of producing dryland rye, they plowed and planted to higher income crops. A few new ditches and laterals still were being constructed on farms this spring, and all should be completed by 1964, Woods says.

"More Acres"—Woods

The nearly doubled acreage on Crooked River Project, now under dependable irrigation, eventually could increase Crook County agricultural income more than $1 million per year, says Woods. He anticipates alfalfa acreage will increase a couple thousand acres, bringing the county total to approximately 10,000 acres.

Woods looks for perhaps two thousand more acres in pasture, grain (primarily barley), and altogether 2,000 acres in commercial potatoes on the new land. He says some crops planted last year on newly watered land were on a demonstrational basis, such as trefoil and mint root stock.

County Agent Woods was awarded the distinguished service award by the National Association of County Agricultural Agents, in September 1962, for "leadership in water conservation programs and livestock marketing activities in Central Oregon," a fitting recognition in the year that marked an upturn in Crook County's irrigation water prospects.

Other benefits from the new project are increased recreation opportunities. Parks and picnic facilities are being developed; boating and fishing already are popular.

And this is the other story, the struggle behind the Crooked River development—

Completion of Crooked River Project had special significance for a number of civic leaders, most of them still living in Crook County, and in particular for one whom Woods calls the "Father of the Crooked River Project," A. R. Bowman.

A Kansan, Bowman visited Pacific coastal states in 1905, and ultimately enrolled in law courses at the University of Washington. For 2 years and a summer between 1907–1910, he worked for the Department of the Interior, Washington, D.C., checking land entries under homestead and similar laws. In Crook County in 1910, he opened his abstract and title insurance office.

By some people, Bowman might be thought of as the godfather of the project. His long campaign began in 1935 with his first effort to interest Government engineers and legislators in redeeming a project that was not fulfilling its original intent. It neared fruition in April 1956 when he and nine colleagues went to our National Capitol to testify before the Subcommittee on Irrigation and Reclamation of the Committee on Interior and Insular Affairs.

Bowman and Others

With Bowman were Woods, LaSelle Coles, Secretary-Manager of Ochoco Irrigation District and current President of the National Reclamation Association, Walter Merritt, Ervin Grimes, Robert L. Barney, Vernon Burda, former Judge Harry Fowler, Ed Donnelly (now deceased), and Claude Williams. They represented business, farming and irrigation. Several Oregon legislators also testified and local chambers of commerce and Oregon banks sent endorsing letters.

Their combined support was the last impetus in a long history of persistent pleas, especially Mr. Bowman's urging construction of the oft-postponed project. Following are some thoughts from Bowman's testimony:

"In 1913, the State of Oregon and the Federal Government jointly surveyed Central Oregon's irrigation potential, and in 1914 issued their report. One item was a complete plan for irrigating Prineville Valley lands from Ochoco Creek, stating it would provide ample water much cheaper than possible from Crooked River. Findings were based on stream measurements from 1905 to 1913, which then were considered sufficient.

"Relying on this report, valley landowners in 1916 organized Ochoco Irrigation District, to water 22,000 acres at an estimated $40 per acre, with a 47,000 acre-foot storage reservoir on Ochoco Creek. Six percent bonds were voted and sold and construction began."

Work was interrupted by World War I and had to be resumed on cost-plus basis, greatly increasing

Mr. Bowman at the Barnes plant.

the burden on district lands. Finally completed, the reservoir filled in 1920 BUT DID NOT FILL AGAIN FOR 17 YEARS. Increased construction costs, decreased farm returns, failing water supply and mounting assessments foreshadowed collapse, and default came in 1926.

Even with greatly reduced acreage in later years, the water supply has not always been ample. In 1934, year of the lowest known runoff of the Ochoco, irrigation water almost disappeared while Crooked River floodwaters covered ranches in the lower valley.

"We learned the hard way that we must look to Crooked River for a firm water supply," said Bowman.

In 1935 Dr. Elwood Mead and R. F. Walter, Reclamation Commissioner and Chief Engineer, respectively, while reconnoitering the proposed North Unit district of Deschutes Valley Project, were prevailed upon to visit Crook County. "They were so impressed," Mr. Bowman continued, "that they directed C. C. Fisher, a Bureau engineer studying the North Unit, to report also on irrigation possibilities on Crooked River Valley lands." Both reports were made in 1936, with the engineer's recommendation that the Crooked River Project be constructed immediately. However, the larger North Unit was built and the smaller Crooked River waited.

In 1940, Reclamation Commissioner John Page visited the Crooked River Project and soon afterwards advised it was being placed on his 1941 program. But in the spring of 1941 war again threatened and President Roosevelt shelved all new projects during the emergency. So Crooked River waited again.

During World War II, the Nation faced food shortages, prompting authorization of immediate construction of 26 irrigation projects including Crooked River, which engineers estimated could be completed in 18 months, the shortest construction time of any. Twenty-five were authorized. Crooked River was not, however, due to lack of strategic materials.

In 1947, the Bureau of Reclamation issued the Columbia River report, a basinwide plan for the complete development of Columbia River drainage area listing Crooked River among 13 projects recommended for immediate construction. Congress approved and authorized the work to be done by Army Engineers but failed to authorize the development program of the Bureau of Reclamation, apparently because of its opposition to the so-called Basin Accounting Plan as proposed in the Columbia River report. So again, the Crooked River Project was deferred—while construction costs climbed.

Crooked River Project Folder proudly shown by Mr. Bowman.

Threatening Despair

Added to rising costs, was the problem created by directive A-47 from Bureau of the Budget which sounded the death knell for all major irrigation projects which did not have the aid of power revenue.

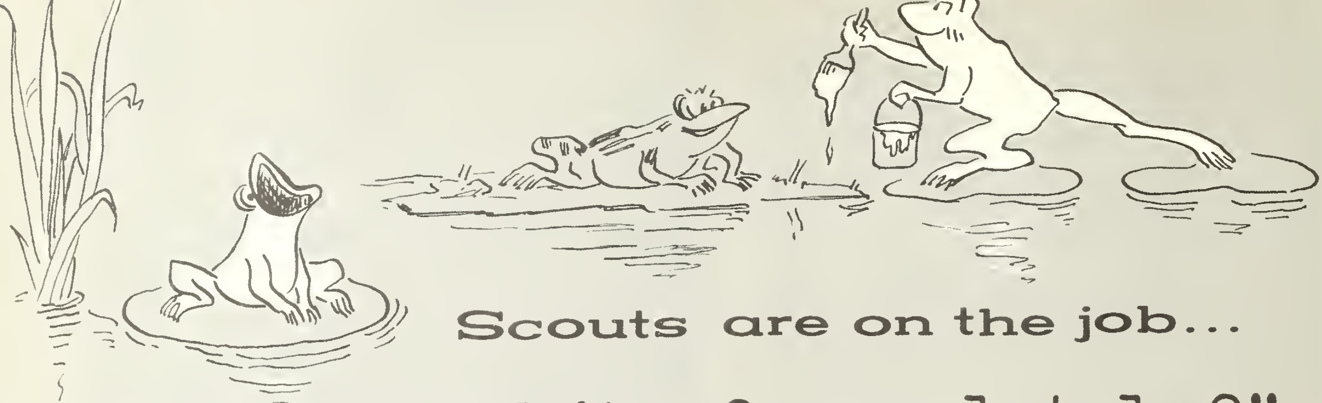
"Admitting that the benefits of control of flash floods on the tributary Crooked River for the Dalles and Bonneville Dams might be somewhat minor," stated Bowman, "we felt we could with some justification lay a claim to revenue of the Dalles Dam for at least a few days in our 50-year repayment period.

"If our project is not authorized, hundreds of thousands of dollars heretofore spent by the Bureau and Army Engineers will be lost . . . and our valley will continue to be ravaged by floods in April and burned up in July."

This despairing observation closed Bowman's testimony.

The plan was ready—a thick volume of data, plans, costs and procedure. On August 12, 1958, Congress authorized "go."

The final act which seemed to uncurve the crooks in Crooked River finally came last year. Dedication ceremonies were held on a pleasant Indian summer day. Mr. Coles, serving his fourth year as president of NRA reviewed the project history. Floyd E. Dominy, Commissioner of Reclamation, then concluded with, "I dedicate this dam and reservoir for the people for now and all time!" # # #



Scouts are on the job...

"Seen any white frogs lately?"

Guest speaker George Miller—"Mr. Boy Scout"—Chief of the Theodore Roosevelt Boy Scout Council in Phoenix, Arizona, used an annual meeting of the U.S. Geological Survey (Arizona area), to challenge industry and other organizations to take the responsibility during summer months of training and providing work for boys who were high school age.

This challenge in turn was presented to Management of the Salt River Project and to its Board of Governors. It was accepted with wholehearted agreement.

The first program started in 1961. Meetings establishing scout qualifications were held:

Minimum age—16
High School graduate
3 years of mathematics
2 years of science
In need of summer employment
In good health

This is one of the many things an Explorer Scout can learn.

Interested scouts submitted their applications to Chief Miller. After review and personal interview, selections were made and the names of six scouts forwarded by Chief Miller to the Salt River Project.

The program consisted of 7 weeks of training, one week in each department, and the final week in the department of greatest interest. Departments chosen were Power Generation, Irrigation Transmission and Distribution, Power Transmission and Distribution, Irrigation Engineering, Purchasing (includes warehousing and printing) and Power Engineering. Scouts were paid the minimum hourly rate.

At the conclusion of this first program, a meeting was held by Scout and Project officials to evaluate the program. The 1962 program was modified in accordance with the recommendations from the group, and from comments of the scouts themselves made at the "graduation luncheon" held on the last day of the eighth week. These changes were:

(1) Scouts should be assigned to one department for the entire program.

(2) Scouts should be juniors and seniors, rather than graduated seniors. This decision was made so that Scouts could benefit from the program by selecting related subjects in high school if a field especially appealed to them.

(3) Extend the program from 8 to 10 weeks.

(4) Expand the program from 6 to 12 scouts.

by H. SHIPLEY,
Associate Salt River Project General Manager
RUTH FAULKNER, Secretary

In April 1962, all interested scouts were invited to Scout Headquarters and presented with a general outline of the Salt River Project, the program, and various job descriptions. At its conclusion, applications were accepted.

After scout officials screened the applications, a second meeting was held to which the qualified applicants were invited. They were interviewed by Project departmental representatives. The interviewers' selections were turned in, and the scouts advised by letter of their acceptance and assignment.

A good evaluation of the program is seen in the excerpts from an unsolicited letter written to the Project by one of the Explorer Scouts who was assigned to the Irrigation Construction and Maintenance Department: (Sic)

"This summer I've had the pleasure of working for the Salt River Project. I've learned a lot from the men I worked with. I don't think there is any better men in any other part of the State or company. I didn't think there was so much work and headaces in water construction. Here are the few things I learned while I worked for the Project. First day I was with the trouble shooters. They were a crew of about three men who went around looking for trouble. The truck had a wench that pulled the spray crew out of a ditch.

"The next day I was with the carpenters. We had to put in a construction about 15E–6N. Its a hard swetting job. With this kind of job it should be done in the morning instead in the afternoon in summer.

"Next I was out with Duke Walker who I think is the best catskinner in the business. Its also the dirtest job in the business. A cat isn't very hard to run. In fact its easier than driving a car.

"Next I was with the spray trucks, spraying weeds in ditchs. There's two different sprays, chemical and oil. Chemical spray is good when its effective. But sometimes its not and it dosen't kill the weeds and we have to go back over it. The oil spray is very good but its the hottest stuff to work with in the sun.

"Next I was with the demossing crew. Boy! if that isn't a wild bunch. You have to be on guard all the time or your soaked. You need a crew like that to keep up everyone's spirit. You put grates in to stop the moss coming down where two cats with a string of disc and a ships anchor chain on the back of it to cut the moss. We picked that stuff out by the truckloads. If we didn't have this, moss would get so thick the water would be stopped.

"I was out on cementing ditch for awhile. That was a hot job. I had to spray this white substance on the wet cement so it wouldn't dry out to fast. And if you see any white frogs it's because I sprayed them.

"I rode around with the bosses. You wouldn't think they work very hard but they do! They got more headaces than anybody I know.

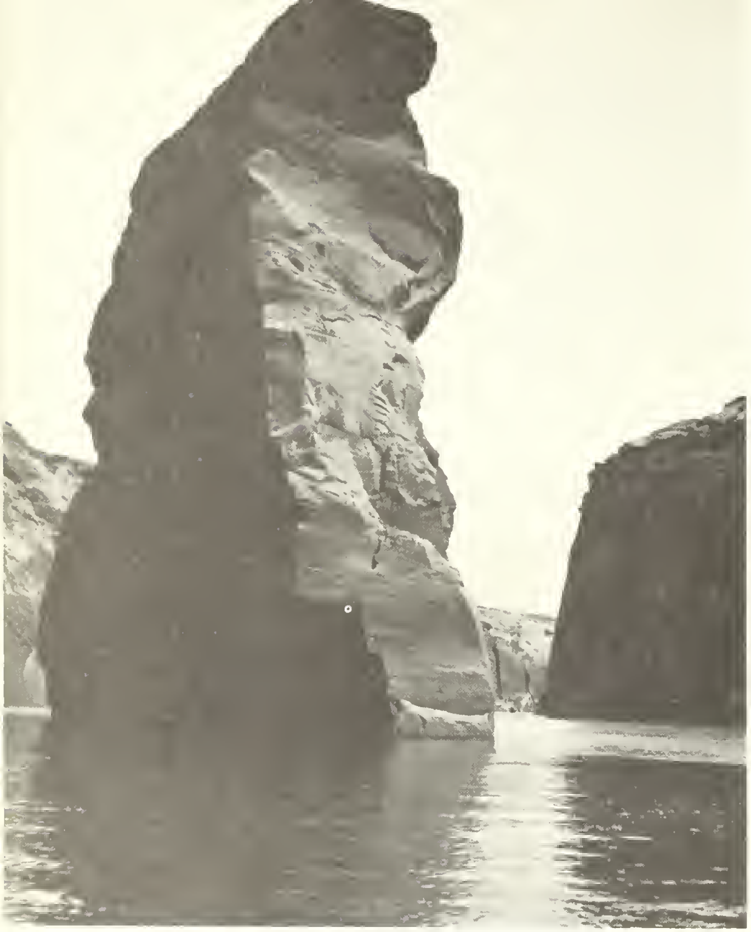
"The men out there (South side C&M) are really good. They answered questions I asked to the full extinct. If I didn't understand they would explain every detail about the job to me.

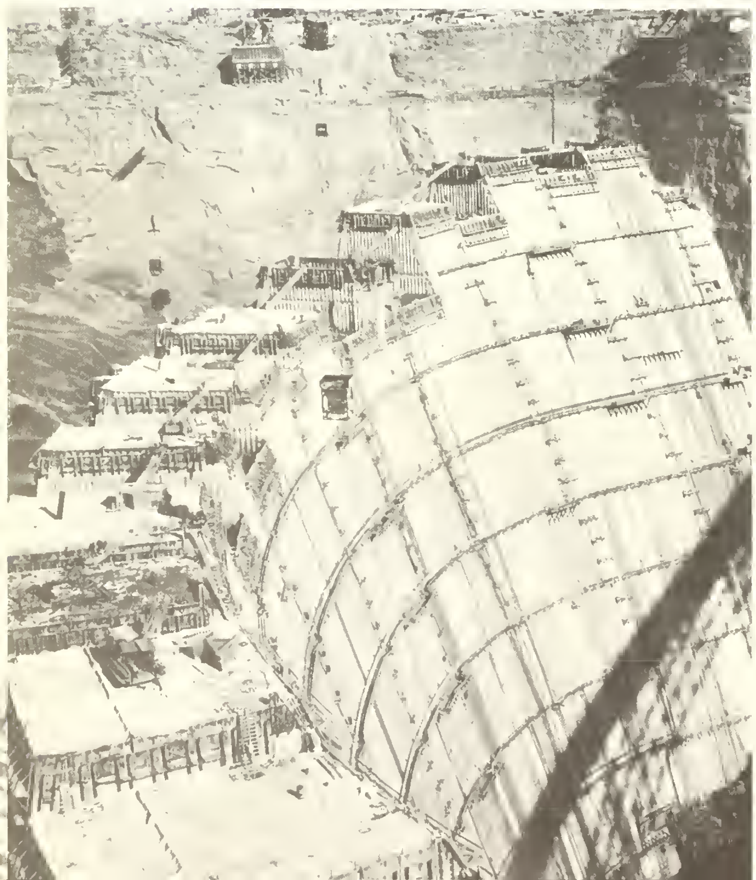
Project officials congratulate Scouts.

"For one thing I hope you keep this program going. It will help a lot of boys. I would very much like to come back to work for the Salt River Project."

We, on the SRP believe this is an effective program for training leaders of tomorrow and for providing appreciation for what Reclamation is doing today.

Knowing Chief Miller's enthusiasm in such a program, the writers commit the Chief's assistance along with ours on the Salt River Project in setting up a similar program in your area. # # #





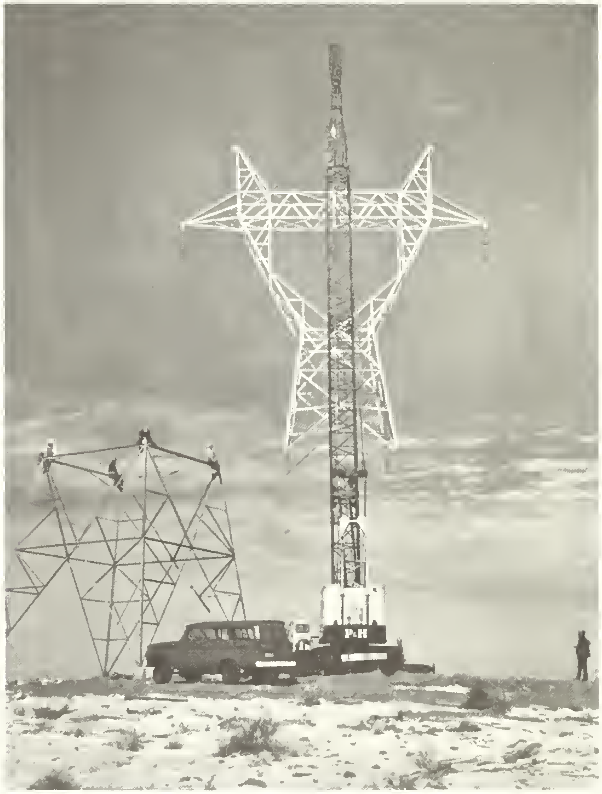
1963—First Payoff on the CRSP

(Continued from page 61)

dry years they could not divert water to depl the Colorado River to less than the flows assur to the Lower Basin under the Compact. In p years of record, the Colorado flows which avera about 13 million acre-feet at Lees Ferry have be as low as 4½ million acre-feet. However, w the CRSP Storage Units, adequate water for t Upper Basin will always be available whether t year is wet or dry.

The CRSP Storage Units have great sign cance for another reason. Irrigation farmers ha long been short of water—have long needed su plemental water and storage dams on the trib taries of the Colorado from which they irrig their farms.

Now, with the CRSP Storage Units, Upp Basin farmers have a paying partner to assist th in meeting the requirements to repay reimbursal costs in full. Powerplants at Glen Canyon Da Flaming Gorge Dam, and the Curecanti U

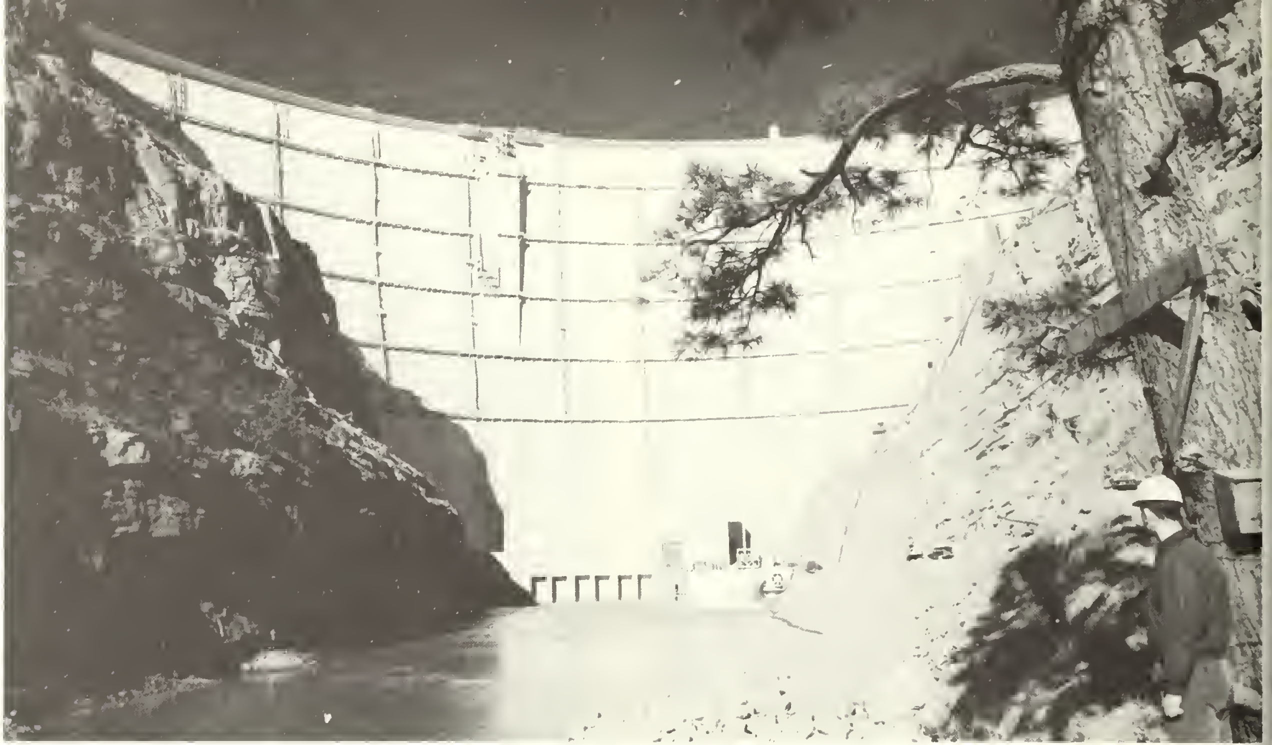


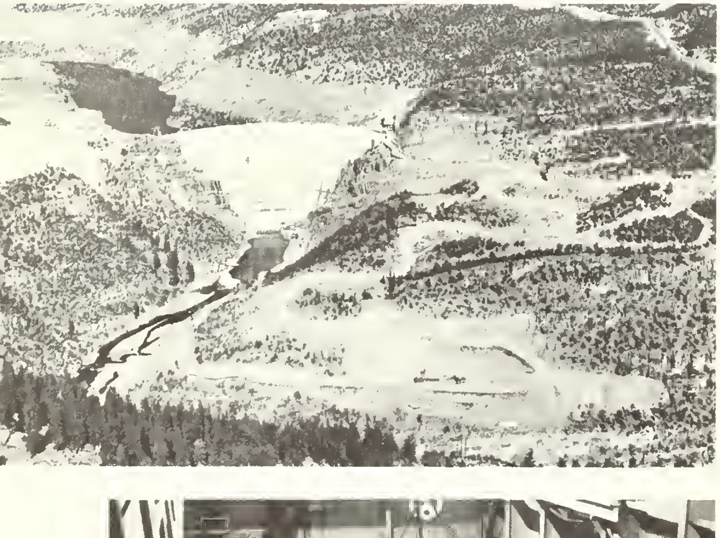
ns, along with some smaller plants on partici-ing projects, will produce marketable power. plus revenues from the sale of the power will nto the Upper Colorado River Basin Fund to st in the repayment of the participating proj-costs. The farmers will repay to the maximum heir ability to do so, and the balance will be id by power revenues accruing to the Basin d. Colorado River System water, which is lated to meet compact requirements, also will used to produce hydro electric power as the er is released through the CRSP powerplants.

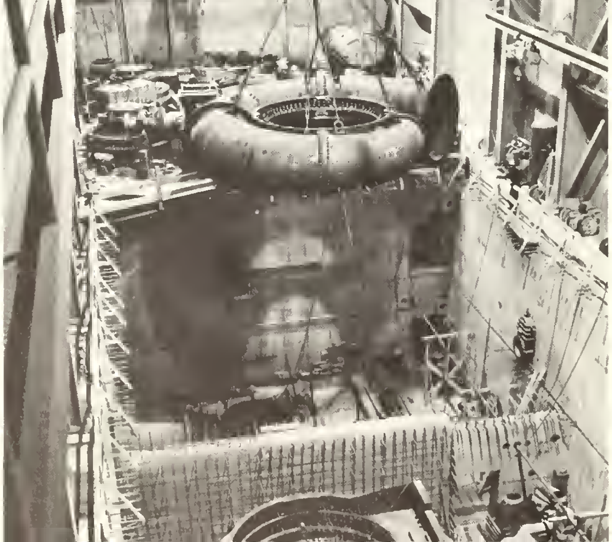
Glen Canyon Dam Nears Completion

len Canyon Dam, the largest and most im-ant of the Storage Unit dams, will be topped this month. Power from the first of the eight 500-kilowatt generators is scheduled to go on line in June 1964. The remaining generators to go on the line at about four-month intervals

Top left—**Sentinel Rock is a strange projectile in the Colorado River.** ***Bottom left***—**A side view of Glen Canyon Dam construction at about 670 feet above bedrock.** ***Top center***—**Two young visitors view Glen Canyon from about a mile downstream.** ***Top right***—**Part of tower of 230-kv transmission line at Glen Canyon-Shiprock being swung into position atop lower body section.** ***Lower right***—**Glen Canyon's first water storage marks dam and canyon walls.**







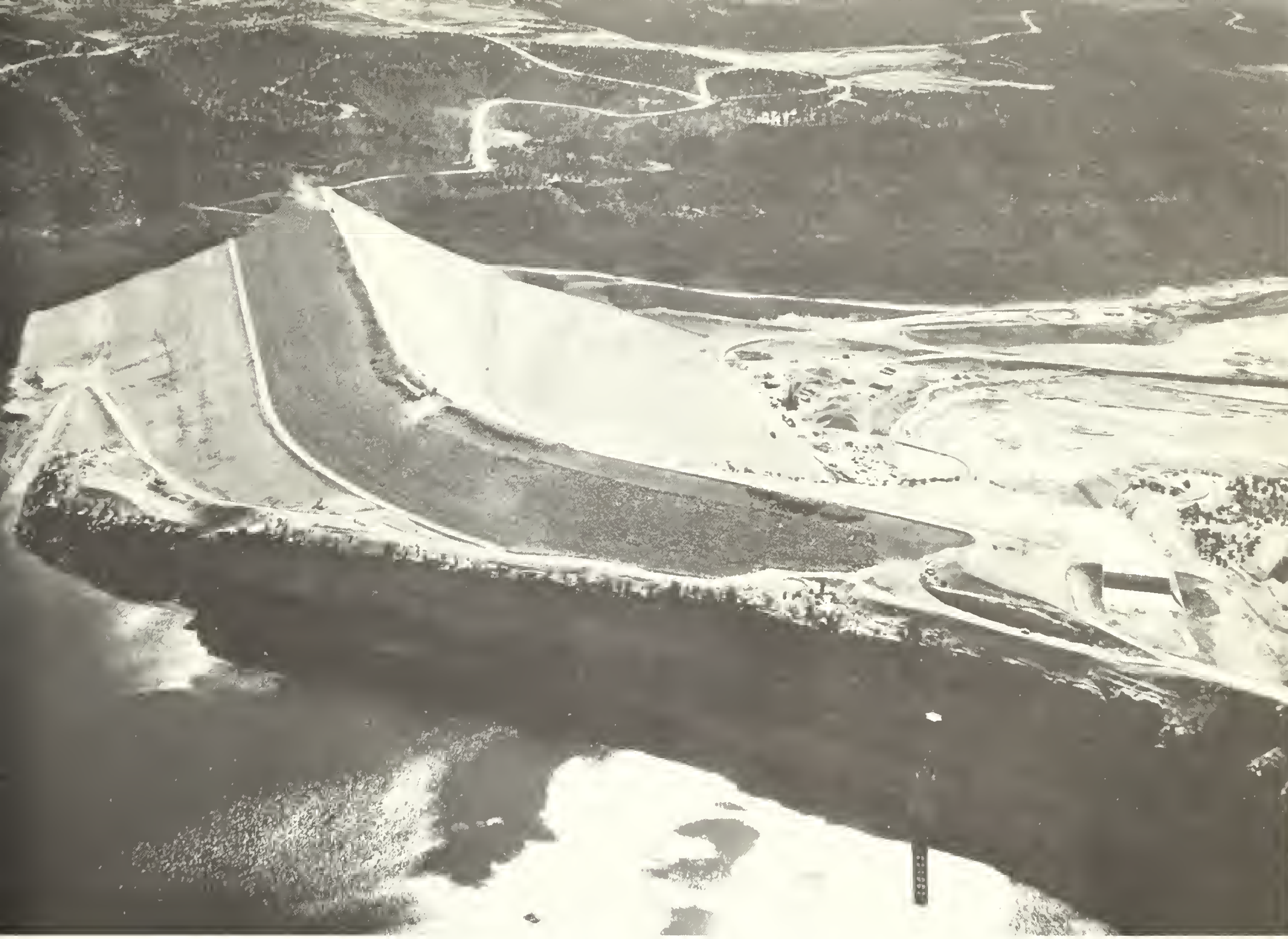
Top—Three views of Flaming Gorge Dam: Above is a close-up; Left, the bad-lands home of the structure; Below, An internal view of a water channel resembling a giant snail shell being lowered into position where it will be cemented into place and direct water to the water wheel for producing power.

with the last generator scheduled for July 1966.

Storage of water in Lake Powell began on March 13. By the end of the year, one of the driest on record, it is expected that Lake Powell will be 120 miles long and contain approximately 3 million acre-feet of water.

Flaming Gorge Power

Water storage began at Flaming Gorge Reservoir on November 1, 1962, and the dam was topped out on November 15. It is the first dam to be built on the Green River. The first of the three 36,000-kilowatt generating units will be ready to go on the line in October of this year with the last generator to go into operation in March 1964, as now scheduled.



Imposing in the New Mexico landscape is Navajo Dam.

Navajo Dam Dedicated

Navajo Dam was completed, essentially, and dedicated in a ceremony held at the damsite in September 1962. Although there will not be a powerplant at the Navajo Dam, it has very important functions in addition to regulation of the flows of the San Juan River. It will make possible the gravity diversion of water directly from the reservoir to the 110,000-acre Navajo Indian Irrigation Project, and from an upstream point to the San Juan-Chama Project, which will take supplemental irrigation water and municipal and industrial water from the San Juan River into the Rio Grande drainage. Municipal and industrial water supplies are urgently needed in this vicinity which includes Albuquerque, New Mexico. Both of the latter projects are authorized and preconstruction surveys are in progress.

Here And On The Way

Participating projects now completed are the Hammond (N. Mex.), Paonia and Smith Fork (Colo.), and the Vernal Unit of the Central Utah Project (Utah). Now under construction are the Emery County (Utah), Florida (Colo.), and Seedskadee (Wyo.). Authorized projects, but not yet under construction are the Central Utah, Initial Phase (Utah), Lyman (Wyo.), Navajo Indian Irrigation (N. Mex.), San Juan-Chama (N. Mex.), and Silt (Colo.). Favorable feasibility reports are completed on the following projects: Animas-La Plata (Colo.-N. Mex.), Bostwick Park (Colo.), Dolores (Colo.), Fruitland Mesa (Colo.), and Savery-Pot Hook (Colo.-Wyo.). # # #

FORTY MORE YEARS WITH THE RECLAMATION ERA . . .

A FEW TOTALS & COMPARISONS

DO YOU KNOW? . . . that the Department of the Interior through the Bureau of Reclamation . . .

	Had constructed as of the AUGUST 1923 *ERA*	Explanation	Has constructed as of the AUGUST 1963 *ERA*
1	100 storage and diversion dams;		310—198 storage; 112 diversion dams (completed)
2	27 miles of tunnel;		152 miles of tunnel (completed);
3	8,000 bridges;	Thousands have been built since 1923; (figure included temporary, wood, & foot bridges)	
4	12,500 miles of canals, ditches, and drains;	Included miles of pipelines and flume	34,300 miles of canals, laterals & drains (excludes ditches, pipeline, & flume)*
5	1,450 buildings;	Included in $143.8 million value of plant property & equipment in projects & facilities	$4.0 billion in value as of 6/30/62*
6	83 miles of railroad;		*
7	560 miles of pipeline;	Probably included in No. 4 above	*
8	130 miles of flume;	Probably included in No. 4 above	*
9	3,000 miles of telephone line;		*
10	1,000 miles of wagon road;		*
11	970 miles of electric transmission line?		11,087 circuit miles of electric trans mission line
12	That it has excavated 200,000,000 cubic yards of material, equivalent to an excavation 1 mile on a side and nearly 200 feet deep?	Excavation probably includes materials from all kinds of dams and other features	*295,410,100 cubic yards of material in earthfill dams only and their appurtenant features built since 1923. Additional millions of cubic yards of material has been excavated for all other types of dams as well as other features.
13	That the storage capacity of the reservoirs is 10,000,000 acre-feet?		*90,900,000 acre-feet in 164 reservoirs completed.
14	That the farms on the projects produce crops of an annual gross value of $50,000,000?		Over $1.2 billion.
15	That since water was first available for irrigating these lands the gross cumulative value of the crops has been $500,000,000?		$18.8 billion.
16	That as a result of irrigation, the value of farm and town property within the projects has been increased another $500,000,000?		*Estimated Federal tax revenues from Reclamation project areas were negligible in 1923, and were $396 million in 1962 [1]; cumulative, not available for 1923, $5.1 billion in 1962.[1]

*Comparative figures or alternative figures are shown in the 1963 column except where no central records have been maintained or are available since 1923.

[1] Estimations on 1962 fiscal year basis.

Two "Geese-Lend" Plans in Farming

1—A look at Stahmann Farms

MAXIMUM use of land and water is the goal of one of the most amazing farms in the southwest. Located in the heart of :he Rio Grande Project, 10 miles south of Las Cruces, New Mexico, Stahmann Farms is an operation involving a complex of farms owned by members of the Stahmann family. Included in the production are pecans, cotton, geese, chickens, and many other related activities. Altogether this farm encompasses almost 4,000 acres of some of :he most productive land in the valley, but the development of the farm has not come easy.

When Deane Stahmann first moved onto this and in 1925 the cultivated area was limited. The remainder was waste land of sand dunes and old river beds, much of which was covered with trees and brush. By clearing and leveling, additional areas were progressively brought into cultivation and included in the pattern of operation.

In the early days cotton was the big crop. In order not to be dependent on only one cash crop, however, Stahmann began setting out pecan trees n his cotton fields. Now the entire farm complex has been planted to pecans and makes up the largest pecan grove in the world; but this is only one facet of this endeavor.

About 14 years ago, Stahmann began raising geese. His first concept was that the geese would assist with the weeding of the cotton planted between the rows of pecan trees, but he soon realized that the geese were much more valuable for furnishing natural fertilizer for the land. So, like most of his endeavors, he began raising geese on a very large scale.

Rynearson's Contribution

For the foundation of his breeding flock, Mr. Stahmann purchased nearly 15,000 goose eggs from Carl Rynearson who is now with the Bureau's Program Coordination and Finance Division in the Washington Office. Once maintaining the largest breeding flock of White Chinese geese in the United States on his Maryland farm near Washington, Mr. Rynearson's incubating eggs were shipped twice a week by air freight to Mr. Stahmann.

Prior to Rynearson's entry into this field, artificial incubation of goose eggs was usually unsuc-

by T. H. MOSER,
Assistant Rio Grande Project Manager,
El Paso, Texas

cessful. He converted chicken egg incubators into goose egg incubators for pioneering in both feeding of the breeding flock and the incubation of goose eggs.

After a year of study and experimentation in proper temperature humidity control, the use of detergent on hatching eggs and the proper food for the breeding flock, Carl obtained higher hatchability of goose eggs than was usual in commercial chicken-egg hatcheries.

In order to sell the geese, Stahmann Farms constructed a slaughtering, processing and quick-freezing plant with a daily capacity of about 3,800 birds. Now a breeder flock of about 12,500 geese, permits shipping of about 200,000 packaged geese every year to markets throughout the country. In addition to this, about 125,000 goslings are shipped to other farmers, who use them as weeder geese.

Not content with only geese to manufacture natural fertilizer, chickens also were introduced into the farm plans and presently number about 50,000 pullets and more than 125,000 laying hens. Unlike the geese that can be put out under the pecan trees at an age of 6 weeks, the chickens are kept in air-conditioned houses in individual cages and are automatically provided with water and custom-made feed. The eggs roll to the front of cages and are gathered nine times daily, from a suspended platform that rolls along a track. The eggs are handled under controlled temperature and humidity conditions.

At the present time 255 cases of eggs are gathered daily, but Stahmann Farms has plans to increase this production as markets for the eggs are developed. When the layers reach 18 months, they are "retired from service" and sold.

Poultry Fertilizer

As Deane Stahmann puts it, the greatest benefit from the poultry is the fertilizer. When mixed with sulphur and sawdust, it provides better plant food and soil conditioner than commercial fertilizers and is completely free of weed seeds, one of the problems with other types of manure. He estimates that the operation derives some $200,000 worth of fertilizer each year from the poultry.

One of the problems in raising poultry has been obtaining fresh feed with the correct nutritional value. Stahmann says, "Good fresh feed is the secret of making a success in the poultry business." In order to insure the best feed, they have recently built a feed mill. This fully automatic operation has a capacity of 75 tons per day and is capable of making 8 varieties of regular feed and 4 medicated feeds.

In spite of the considerable size of the geese and chicken activities, pecans remain the primary crop. The present practice of heavy pruning decreases production but improves the quality of the nuts and allows for closer spacing of the trees as can be seen in the picture on page 77. The new trees for replacement planting come from the nursery operated as an adjunct to the farm. Although about 100,000 trees are raised each year the majority are sold to other farmers and individuals in every part of the country.

Two ultra-modern pecan cracking plants are also operated by Stahmann Farms. Between 6 and 7 million pounds of nuts are shelled, graded, sized and packaged for shipment to all parts of the United States and to foreign countries. Although the shelling and packaging process requires a considerable amount of hand labor, mechanization of this work is used to the fullest extent.

Breeder geese on Stahmann Farms

Cotton Crops

Not to be overlooked in this farming operation is the original money crop—cotton. By continuous breeding since 1937, Stahmann has developed the "Del Cerro" variety of good producing, high-quality cotton, which is efficiently grown in narrow strips between the rows of trees.

One reason this complex farming operation is so highly productive is the interest and attention paid to improving the soil. Continual fertilization, deep plowing and leveling are recognized as good farming practices. In addition to these, however, is "soil swapping"—moving soil from one area to another. By this work areas of different types of soil, such as heavy clay and sand, are blended to make a more productive soil. Since this land was originally criss-crossed by many old river beds, the soil on the farm was far from homogeneous. Much improvement by means of "soil swapping" has already been made and Stahmann feels this work should continue as long as it will increase production.

Although Deane Stahmann has been the driving force in the development of this intra-family operation, he is by no means the only one responsible for the efficient operation of the enterprise. Not only do his two sons, Deane, Jr. and Bill, play an important part, but he recognizes that the work of every one of the many employees is necessary for the continued success of the farm.

Consequently, a benefit plan, wherein the employees share in the profits of the operation, has been developed. The plan provides for vacation pay, medical insurance, cash bonuses, a profit-sharing trust fund, and a pension trust, in which all permanent employees are included. It is this feature of employer-employee relations that Deane Stahmann is most proud.

So the combination of good management, efficient and conscientious employees, and widely diversified farming has made Stahmann Farms a showplace of the southwest. # # #

One of the main canals of the Rio Grande Project. Used for irrigating the Stahmann Farms.

And on the Columbia Basin Project

2-Helpers on the Mint Farm

SINCE the coming of the Columbia Basin Project in south-central Washington state, the waterfowl population, attracted by the large quantity of available water and feed in the area, has boomed.

But on a large mint farm owned by Felix Kinne in the project's Irrigation Block 74 near Quincy, and at several other mint farms throughout the 457,000 irrigable acre project, hundreds of domestic geese are brought into the area each spring to assiduously apply their long noses to a back-breaking job, and all for less than peanuts—as a matter of fact, for *weeds*.

The first mint to be raised on the Project was a small acreage in Block 1 in 1949, the first year that irrigation water reached project lands. Since that time, the annual mint harvest has grown to a current average acreage of about 2,500 acres.

Among the several unique aspects of mint raising is one that is also its chief problem; the plants grow only about 30 to 36 inches high making thorough mechanical weeding impossible. Consequently man-labor is usually the biggest single expense in mint operations. That's where the geese come in. And in the case of Mr. Kinne, who raises about 800 acres of mint annually, each spring, geese come in almost by the thousands.

"I was sold on the idea of using the geese one day while watching a young goose working its way down the row of a mint field in Sunnyside, eating weeds as it went," Kinne said. "I couldn't help thinking that I had to pay for weeding and this bird was doing the same thing for free and feeding itself at the same time."

Since that time, thousands of geese have plodded down the rows of Kinne's mint fields plucking out

Part of Felix Kinne's 1963 crop of goslings.

weeds such as Chinese Lettuce, a particular favorite, from under the mint plants, even though the young weeds are sometimes so small as to be almost invisible. Mr. Kinne claims that the geese only rarely eat the mint plant. When the weed pickings are particularly slim the geese's diet is occasionally supplemented with corn.

"Just after the irrigation season begins I buy about 1,500 goslings. After 8 or 10 weeks in roofed pens the goslings have feathers and are ready to go to work," Kinne said. Even though the mint fields are fenced by the time the irrigation season is over and the last of the mint is harvested, this number is reduced by at least half, principally by the depredations of dogs and coyotes. "But we're having less trouble now with the coyotes," Kinne said. "The Fish and Wildlife service is helping to get rid of them."

The surviving geese are sold back to the hatchery and to neighbors in plenty of time for Thanksgiving. However, as might be expected, there are a few geese in Kinne's area that were sold for dinner which stayed as live pets.

Aside from the geese weeders, processing valuable mint oil is also one of his industries. The oil is used by such firms as Colgate and Wrigleys in a large variety of gum, toothpastes, and candies.

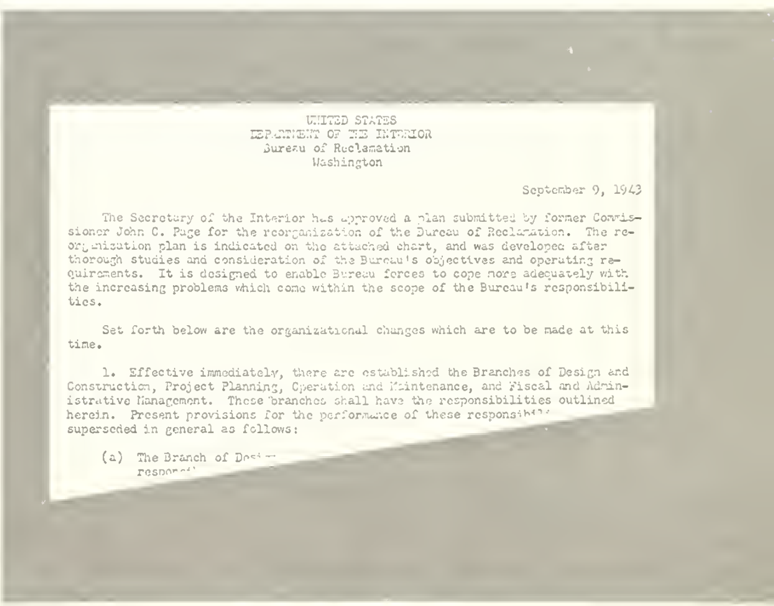
On most of the project's larger mint operations, such as Mr. Kinne's, processing of the mint oil takes place right on the farm. After the mint is cut, a field chopper is usually used to pick it up, chop it and load it into a truck-mounted metal tank. When the tank is filled, the next stop is the distillery where the mint is steamed until the oil in the leaves is vaporized. This vapor then is condensed, separated from the water, and stored in barrels for later shipment. The whole distilling process takes about 2 hours, from shredded plant to oil.

Geese and high-geared mechanized distilleries may be incongruous, but they are co-workers in mint production on the Columbia Basin Project. # # #

REGIONS to celebrate 20th ANNIVERSARY 1943—1963

The 20th anniversary of the establishment of regional administration of the Bureau of Reclamation by river basins, which occurred on September 9, 1943, will be marked throughout the Bureau. Region 7 was established a year later, but will join the other six regions in Bureau-wide recognition.

Each region will conduct its own observance and highlight its accomplishments and purpose to the public. The regional observances will be coordinated with National Public Works Week during September 8–14. # # #


UNITED STATES
DEPARTMENT OF THE INTERIOR
Bureau of Reclamation
Washington

September 9, 1943

The Secretary of the Interior has approved a plan submitted by former Commissioner John C. Page for the reorganization of the Bureau of Reclamation. The reorganization plan is indicated on the attached chart, and was developed after thorough studies and consideration of the Bureau's objectives and operating requirements. It is designed to enable Bureau forces to cope more adequately with the increasing problems which come within the scope of the Bureau's responsibilities.

Set forth below are the organizational changes which are to be made at this time.

1. Effective immediately, there are established the Branches of Design and Construction, Project Planning, Operation and Maintenance, and Fiscal and Administrative Management. These branches shall have the responsibilities outlined herein. Present provisions for the performance of these responsib[illegible] superseded in general as follows:

(a) The Branch of Des[illegible]

RECORD MILLIONS Seek Recreation At Projects

THE equivalent of one out of every seven persons in the United States visited a recreation area on a Bureau project last year. Statistics indicate that new high of 27 million visitor-days recorded at Bureau recreation areas during 1962 are approximately four times the number estimated for 1951 and represent an increase of 1.4 million over the 25.6 million figure for 1961.

By far the greatest number of visitors to these recreation areas last year went primarily to view the scenery. They found that the superb natural beauties of Western mountains, lakes, and plains have been enhanced by breath-taking man-made splendors—impressive Reclamation dams and reservoirs with 9,000 miles of spectacular shoreline. Guided tours of the larger installations are proving increasingly popular with the swelling stream of tourists.

Visitor-days recorded for sightseeing enjoyment at the recreation areas last year totaled 10.2 million. Another 5 million were spent fishing in reservoirs and other waterways. Picnicking accounted for 3.3 million visitor-days, water skiing for 2.5 million, camping for 2 million, boating for 1.6 million, and hunting for .2 million.

The 191 recreation areas at Bureau projects comprise 4,126,546 acres of land and 1,350,506 acres of water, with 89 percent of the land and 96 percent of the water available to the public for various sports. Facilities for public use vary considerably among the different projects, since they include those installed at the time the projects were built, development undertaken by the recreational management agencies, facilities built by concessionaires and organized camping groups such as Boy Scouts and church associations, pri-

vate cabins, and a few installations of semi-private organizations, such as water skiing and boating clubs. The accommodations include parking areas, campgrounds, rest rooms, picnic areas and tables, drinking water outlets, swimming beaches, boat ramps and docks, and summer homes. In addition 218 concessionaires supply public lodging and eating establishments.

Bureau statistics show that the reservoirs of multi-purpose Reclamation projects contribute significantly to migratory waterfowl conservation, a Reclamation function closely allied to recreation. Both wild ducks and wild geese utilize these water impoundments as resting areas during spring and fall migrations and, to a lesser extent, for nesting and feeding during the remainder of the year. More than a half million acres of land and water on the projects comprise wildlife refuges. Hunting is permitted during open season on 4 million acres, or 73 percent of all land and water in the project recreation areas.

Total value of recreation facilities on Reclamation projects is approximately $50.2 million, of which only $6 million represents investment by the Bureau of Reclamation, $22.4 by other Federal and non-Federal administering agencies, and $13.2 by concessionaires. Operation and maintenance of all public-use facilities totaled $7.2 million last year and provided approximately 600 man-years of employment. # # #

The water's edge camping shown on page 80 is at Shadow Mountain Reservoir, Colorado. Below, the swimming and boating scene is at Black Canyon Reservoir, Boise, Idaho.

Helicopter used as ECONOMY WORKHORSE

An estimated $2,000 was saved through the use this spring of a helicopter to transport drilling equipment for geological investigations on the San Luis Unit of the Bureau's Central Valley Project near Los Banos, California.

In addition to the savings, use of the helicopter expedited equipment handling, advancing the drilling schedule a full 2 weeks.

In 3 hours and 42 minutes of total flying time, the helicopter transported the drilling rig, all miscellaneous tools, decking, rods, casing, pipeline, and 110 gallons of gasoline from the Los Banos Airport to the drilling site, a distance of about 25 miles. By comparison, the move onto a nearby site in 1962 by the conventional method required a crew of six, 2 weeks to complete.

Site of the recent drilling work was on a ridge approximately 1,000 feet above the Los Banos Creek valley floor. By ground, the only access was up slopes that averaged almost 1½:1, and in places there were a series of 20-foot vertical steps. The ground surface was littered with loose rocks, and at the upper elevation of the ridge there were few trees to which the rig might have been tied.

In the helicopter transport, the drilling rig was broken down into three pieces: the skids, motor, and the radiator and gasoline tank.

Based on the 1962 experience, it is estimated that the recent on-site move using the conventional method would have required 90 man-days—a total cost of $2,484—and miscellaneous equipment charges, such as bulldozer rental, were estimated at $500. Direct costs for the move were thus estimated to total almost $3,000.

Costs of the move utilizing the helicopter were 4 man-days spent in packaging and preparing equipment, a total of about $110; a 6 man-days in completing the setup and reassembly of the drilling rig, a total of $165; and helicopter rental of about $450. Total cost of the helicopter move $725, a savings of more than $2,000 over the conventional method.

Use of the helicopter also made possible increased safety of the operation over the conventional move. Moving heavy equipment to the top of the ridge up steep slopes, where poor footing is inherently dangerous, was obviated by the helicopter technique. # # #

KEY PERSONNEL CHANGED

MR. DENIT LEAVES RECLAMATION TO TAKE DEPARTMENTAL POSITION

Having gained many friends and the respect of co-workers and people in high positions because of his abilities, it is with regret that Reclamation staffers saw W. Darlington Denit leave for his new appointment with the Department. In May, after 2 years as the Bureau's Assistant Commissioner for Administration, he was appointed by Secretary Udall as Director of the Department's new Office of Surveys and Review.

Mr. Denit has written and lectured extensively on topics in the public administration field. He has had extensive responsible experience in the fields of financial management, auditing, and compliance activity in Interior and other Federal agencies and in industry.

In his new post, Mr. Denit directs selective audits, reviews and investigations. He had served from 1955–61, just prior to his Bureau position, as Director of the Department of the Interior's Inspection Division.

Daniel V. McCarthy Named Division Chief

Daniel V. McCarthy was named Chief, Division of Project Development in May, succeeding Donald R. Burnett, who recently accepted a position in the Philippines as a Project Engineer.

Mr. McCarthy, a native of Nichols, New York, received his bachelor's degree in civil engineering from Pennsylvania State University in 1934. He has devoted his entire career to water resources development, with the Tennessee Valley Authority, the U.S. Army Corps of Engineers, the National Resources Planning Board, and during World War II with the Water Division of the War Production Board. He joined Reclamation in 1945 and became Assistant Chief of Project Development in 1959.

Pierce Steps in as Alaska Manager

George N. Pierce was appointed in April as new manager of the Alaskan District, coming to the post with extensive experience with the Bureau and the Tennessee Valley Authority in power planning, marketing and other fields of Reclamation developments.

He succeeds Daryl L. Roberts who was assigned to the new Philippine's office which is studying multipurpose development of seven major river basins under auspices of the Agency for International Development.

Born in 1911 in Buffalo, New York, Mr. Pierce matriculated first at the University of North Carolina and completed his work for a degree in civil engineering at the University of Cincinnati in 1936.

MAJOR RECENT CONTRACT AWARDS

Specification No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-5853	Colorado River Storage, Utah-Wyo.-Colo.-Ariz.-N. Mex.	May 17	Furnishing and installing a multichannel microwave radio system for supervision and control between Flaming Gorge, Vernal, Hayden, Cheyenne, Archer, Rifle, Curecanti, and Montrose; and between Montrose, Shiprock, Glen Canyon, Flagstaff, Pinnacle Peak, and Phoenix.	General Dynamics Corp., Stromberg-Carlson Div., Rochester, N.Y.	$2, 278, 36
DC-5877	Seedskadee, Wyo	Apr. 8	Construction of Fontenelle powerplant and switchyard.	E-W Construction Co. and L. D. Shilling Co., Inc., Creswell, Oreg.	1, 335, 6
DS-5890	Central Valley, Calif	May 7	Three vertical-shaft, centrifugal-type pumps; three vertical-shaft, mixed-flow-type pumps; and three control units for Mile 18 pumping plant.	English Electric Corp., New York, N.Y.	1, 950, 00
DS-5895	Colorado River Storage, Ariz	Apr. 2	Twelve 8,000-kva shunt reactors for Pinnacle Peak substation.	General Electric Co., Denver, Colo.	155, 66
DS-5898	Missouri River Basin, Mont.-Wyo.	Apr. 10	Two 25-foot by 64.4-foot raidal gates for spillway intake structure at Yellowtail Dam.	Mitsubishi Nippon Heavy-Industries, Ltd., c/o Mitsubishi International Corp., New York, N.Y.	168, 16
DC-5900	Central Valley, Calif	Apr. 29	Construction of 16 miles of concrete-lined San Luis canal, Sta. 37+50 to 870+00, utilizing prestressed precast concrete beams for bridge.	Guy F. Atkinson Co., South San Francisco, Calif.	16, 493, 78
DC-5902	Florida, Colo	Apr. 30	Construction of 17.5 miles of unlined Florida laterals, wasteways, and ditches.	J. F. Schroeder's Sons, Ordway, Colo.	355, 90
DC-5903	Colorado River Storage, Ariz	May 10	Construction of the 22-mile Pinnacle Peak-Mesa 230-kv transmission line.	Schurr and Finlay, Inc., Yorba Linda, Calif.	786, 51
DS-5904	Colorado River Storage, N. Mex	Apr. 5	Seventeen 230-kv, eleven 115-kv, and six 15-kv disconnecting switches for Shiprock substation, schedule 1.	Schwager-Wood Co., Inc., Portland Oreg.	104, 45
DC-5907	Colorado River Storage, N. Mex	Apr. 17	Construction of Shiprock substation, stage 01	Reynolds Electrical & Engineering Co., Inc., Santa Fe, N. Mex.	582, 15
DS-5911	Central Valley, Calif	June 4	Six vertical-shaft, mixed-flow-type pumps and control units for San Luis forebay pumping plant.	Fairbanks, Morse & Co., Hydraulic & Special Projects Div., Denver, Colo.	754, 42
DC-5913	Gila, Ariz	May 15	Construction of 3.5 miles of concrete-lined canal, 10 miles of pipeline laterals, and structures for South Gila Valley Unit distribution system, schedule II, utilizing cast-in-place pipe for the laterals, schedule 1.	Sandkay Construction Co., Inc., Ephrata, Wash.	814, 73
DC-5914	Lower Rio Grande Rehabilitation, Tex.	May 10	Clearing, and construction of earthwork and structures for rehabilitation of Main canal, Sta. 0+00 to 279+86, and modification of Lateral C intake structure.	Dodds & Wedegartner, Inc., San Benito, Tex.	272, 39
DC-5915	Colorado River Storage, Colo	May 14	Construction of Morrow Point Dam and powerplant	Al Johnson Construction Co. and Morrison-Knudsen Co., Inc., Minneapolis, Minn.	15, 436, 06
DC-5916	Missouri River Basin, S. Dak	May 10	Construction of the 61-mile Martin-Philip 115-kv transmission line.	Hall-Barovich Construction, Rapid City, S. Dak.	543, 03
DC-5917	do	May 20	Construction of stage 06 additions to Sioux Falls substation.	Ets-Hokin and Galvan, Inc., Denver, Colo.	655, 00
DC-5920	Emery County, Utah	May 10	Construction of Joes Valle Dam	S. S. Mullen, Inc., Seattle, Wash	3, 562, 2
DS-5921	Colorado River Storage, Colo.-Ariz.-Utah-N. Mex.	May 29	Furnishing and installing digital dispatching system for multiple-plant load and frequency control and auxiliary uses for Montrose power operations center, Flaming Gorge and Glen Canyon powerplants, and telemetering points.	General Electric Co., Denver, Colo.	455, 43
DS-5924	Columbia Basin, Wash	May 31	Eight vertical-shaft, turbine-type pumping units and eight 300-kva unit power centers for emergency drainage of Grand Coulee powerplant.	Fairbanks, Morse & Co., Hydraulic & Special Projects Div., Denver, Colo.	195, 30
DC-5925	Norman, Okla	May 17	Construction of 29 miles of water conduit for Norman, Midwest City, and Del City pipelines.	International Pipe & Ceramics Corp., East Orange, N.J.	2, 759, 54
DC-5927	Colorado River Storage, Colo	May 31	Construction of Vernal-Hayden and Hayden-Green Mountain 138-kv transmission lines in the vicinity of Hayden substation, schedules 1 and 2.	L. O. Brayton & Co., Dyersburg, Tenn.	142, 41
DS-5928	Central Valley, Calif	June 4	One 350-ton and one 50-ton traveling crane for San Luis pumping-generating plant.	Star Iron & Steel Co., Tacoma, Wash.	232, 91
DC-5929	Hungry Horse, Mont	June 3	Construction of a tour center for Hungry Horse Dam, schedule 1.	Montana Builders, Kalispell, Mont.	112, 11
DC-5930	Missouri River Basin, Nebr	June 7	Construction of 64 miles of Ainsworth laterals and wasteways and 5 miles of drains, section 1.	Missouri Valley Construction Co., Grand Island, Nebr.	1, 519, 42
DS-5942	Missouri River Basin, Kans	June 17	Three 30-foot by 36.35-foot radial gates for spillway gate structure at Norton Dam, schedule 1.	McNally Pittsburg Mfg. Corp., Pittsburg, Kans.	130, 67
DS-5947	Colorado River Storage, Colo	June 18	Two 84-inch hollow-jet valves for outlet works at Blue Mesa Dam.	Goslin-Birmingham Mfg. Co., Inc., Birmingham, Ala.	112, 29
DC-5952	Missouri River Basin, Mont	June 20	Stringing conductors and overhead ground wires for 160 miles of Dawson County-Custer section of Yellowtail-Dawson County 230-kv transmission line.	Main Electric, Inc., and Aloysius D. Hagenstein, Minot, N. Dak.	1, 534, 92
100C-613	Columbia Basin, Wash	Apr. 19	Construction of 11 miles of pipe drains for D78-37, D78-37-1, D78-57, D78-121, and D78-126 systems, Block 78.	Sandkay Construction Co., Ephrata, Wash.	158, 82
300C-186	Colorado River Front Work and Levee System, Ariz.-Calif.	June 14	Construction of an inlet channel to the sediment retention basin between Imperial and Laguna Dams.	Arrow Construction Co., Inc., Yuma, Ariz.	111, 48
DC-5932	Missouri River Basin, S. Dak	June 24	Construction of stage 02 and 03 additions to Philip substation.	Electrical Builders, Inc., Valley City, N. Dak.	472, 75
DC-5935	Weber Basin, Utah	June 24	Construction of Lost Creek Dam	Steenberg Construction Co., St. Paul, Minn.	2, 053, 00
DC-5937	Missouri River Basin, Wyo.-Neb.	June 27	Construction of the 61-mile Archer (Cheyenne)-Stegall 230-kv transmission line.	Electric Properties Co., Lincoln, Neb.	1, 702, 38
DC-5945	Chief Joseph Dam, Wash	June 25	Construction of 16 miles of pipelines, including reservoirs and pumping plants, for Brays Landing Unit lateral system.	Armstrong and Armstrong, Wenatchee, Wash.	1, 252, 24
DC-5959	Minidoka and Palisades, Idaho	June 28	Construction of stage 02 additions to Heyburn and Goshen substations.	Carrel Electric, Twin Falls, Idaho	170, 53

Major Construction and Materials for Which Bids Will Be Requested Through August 1963*

Project	Description of work or material
Canadian River, Tex	Constructing about 90 miles of pipelines of precast-concrete pressure pipe for heads ranging from 25 to 100 ft in sizes of 54-, 60-, 66-, and 72-in. diameter, and one earth-lined reservoir of 500 acre-feet capacity with about 29 acres bottom area. Main Aqueduct, from vicinity of Canyon, to vicinity of Lubbock, Tex.
Central Valley, Calif	First-stage construction for the 13,100-cfs-capacity Mile 18 Pumping Plant. Work will consist of earthwork; discharge lines with prestressed monolithic and steel alternatives; constructing a reinforced-concrete plant substructure with a structural-steel frame and brick superstructure, an outlet structure, and a short reach of inlet and outlet concrete-lined canal. About 9 miles south of Los Banos.
Do	Constructing prefabricated field offices, laboratory and automotive shop, and underground gasoline storage facilities. Work will also include asphalt surfacing parking areas and service yard, and chain-link fencing area. San Luis damsite, near Los Banos.
Do	Sixteen draft tube bulkhead gates, including lifting frame, and seats and guides, for sixteen 15-ft 11-in. by 12-ft 9-in. draft tube openings for the San Luis Dam Pumping-Generating Plant. Estimated weight: Gates—223,000 lb; seats and guides—95,500 lb.
Colo. River Front and Levee System, Ariz.-Calif.	Six centrifugal-type vertical-shaft, pump turbines each with a pumping capacity of 100 cfs at a total head of 74 ft for the Senator Wash Pumping-Generating Plant.
CRSP, Colo	Constructing an 80- by 178-ft warehouse and a 60- by 178-ft storage garage, both to be of steel frame with metal panels. Power Operations Center at Montrose.
Do	Constructing a 100- by 155-ft maintenance shop and a 60- by 155-ft service garage. Power Operations Center at Montrose.
Gila, Ariz	Constructing about 4.5 miles of 4-ft bottom width concrete-lined canal and about 12.6 miles of 30- to 48-in. diameter cast-in-place or precast-concrete pipe laterals. South Gila Canal and Laterals, Unit 2, near Yuma.
MRBP, Colo	One 115-69-12.47-kv, 10,000/12,500-kva power autotransformer for Limon Substation.
MRBP, Iowa and Mo	Furnishing and constructing about 63 miles of 161-kv, wood-pole Creston-Maryville Transmission Line; and furnishing and stringing three 556 MCM, 24/7, ACSR conductors and two ⅜-in., high-strength, steel strand, overhead ground wires. Along alinement extending from near Creston, Iowa, to near Maryville, Mo.
MRBP, Iowa	Additions to the Sioux City Substation, Stages 04A and 05, will consist of constructing concrete foundations; furnishing and erecting steel structures; furnishing and installing two 230-kv and two 161-kv circuit breakers and associated electrical equipment; and grading and fencing the additional substation area.
MRBP, Mont	Furnishing and installing fence gates; clearing right-of-way; constructing concrete footings; furnishing and erecting steel towers for about 60 miles of 230-kv, single-circuit transmission line; and furnishing and stringing three 954 MCM, ACSR conductors and two ½-in. steel strand, overhead ground wires. Custer-Yellowtail Section of Yellowtail-Dawson County Transmission Line, from the Yellowtail Dam Switchyard to Custer.
MRBP, Nebr	Constructing about 26 miles of unlined canals with bottom widths varying from 18 to 4 ft and about 62 miles of unlined laterals with bottom widths varying from 6 to 4 ft. Farwell South and Upper South Canals and Laterals, near Boelus.
MRBP, N. Dak	Additions to the Fargo Substation, Stage 07, will consist of constructing concrete foundations; furnishing and erecting steel structures; and installing two 230-kv, two 115-kv, and two 13.8-kv circuit breakers, and associated electrical equipment, major items of which will be Government furnished.
Do	Two 230- to 115-kv, 33,333-kva, single-phase mobile autotransformers.
MRBP, S. Dak	Preparing about 24,000 lin ft of canal subgrade and 5,100 lin ft of lateral subgrade for buried asphaltic membrane lining, and furnishing and applying asphaltic membrane lining and earth and gravel cover. Angostura Unit, near Hot Springs.
MRBP, Wyo	Furnishing and constructing about 33 miles of 115-kv, wood-pole Glendo-Lusk Transmission Line; and furnishing and stringing three 477 MCM, ACSR conductors and two ⅜-in. steel strand, overhead ground wires. Along alinement extending from near Glendo to near Lusk.
MRBP, Wyo.-Mont	Earthwork, structures, and track for about 5 miles of CB&Q RR near the upper reaches of Yellowtail Reservoir. Near Kane, Wyo.
Norman, Okla	Clearing and burning trees and brush and removing and disposing of fencing, buildings, foundations, bridges, and other miscellaneous structures from Norman reservoir area. Near Norman.
Rio Grande, N. Mex	Constructing a residence, a shop and warehouse building, about 3 miles of roads, and recreational facilities. Elephant Butte Reservoir, near Truth or Consequences.
Seedskadee, Wyo	Furnishing, installing, and testing one vertical-shaft, 10,000-kw, 150-rpm, 0.9-pf, 4,160-volt generator with direct-connected exciter. Fontenelle Powerplant.
Do	One 10,500/12,500-kva, 69- to 4.16-kv, OA/FA, 3-phase generator voltage, power transformer for Fontenelle Powerplant Switchyard.
Washita Basin, Okla	Constructing about 250 ft of 42-in.-diameter precast-concrete pressure pipe to connect existing pipelines. Foss Aqueduct, near Stafford.

*Subject to change.

U.S. GOVERNMENT PRINTING OFFICE : 1963 O—690-636

In its assigned function as the Nation's principal natural resource agency, the Department of the Interior bears a special obligation to assure that our expendable resources are conserved, that renewable resources are managed to produce optimum yields, and that all resources contribute their full measure to the progress, prosperity, and security of America, now and in the future.

U.S. Department of the Interior

Bureau of Reclamation

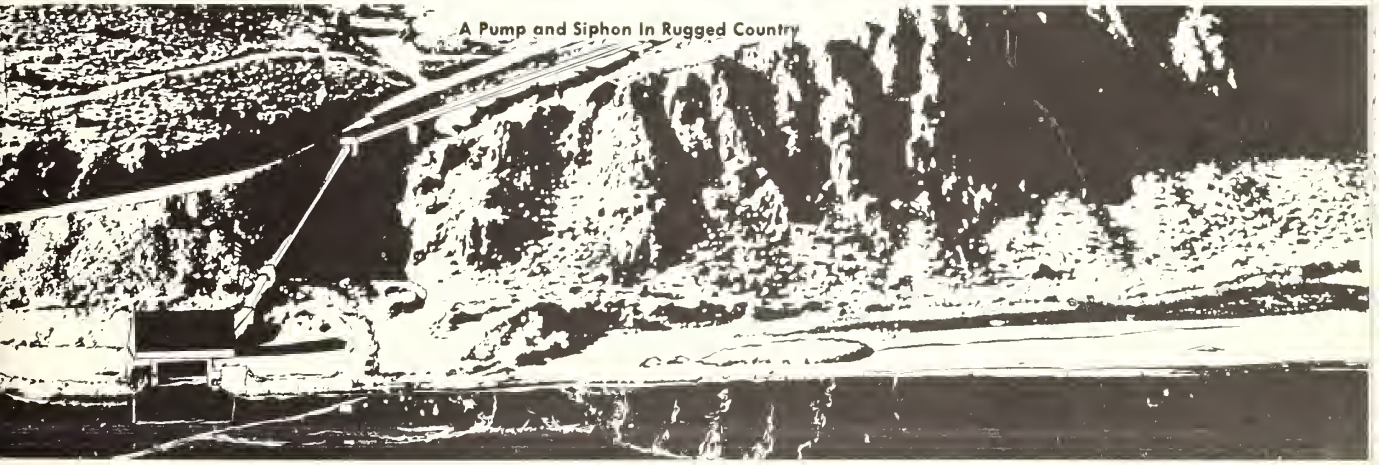
What's Coming:

Soil Cement Protection Pays

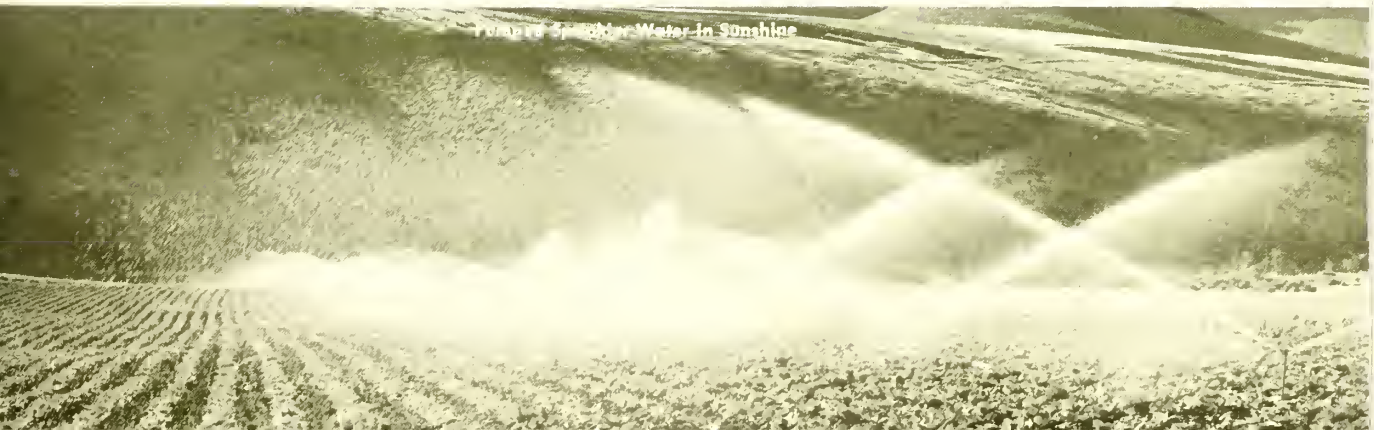
November 1963

Reclamation ERA

Unclogging A Canal



A Pump and Siphon In Rugged Country



[illegible] Water In Sunshine

Reclamation ERA

NOVEMBER 1963

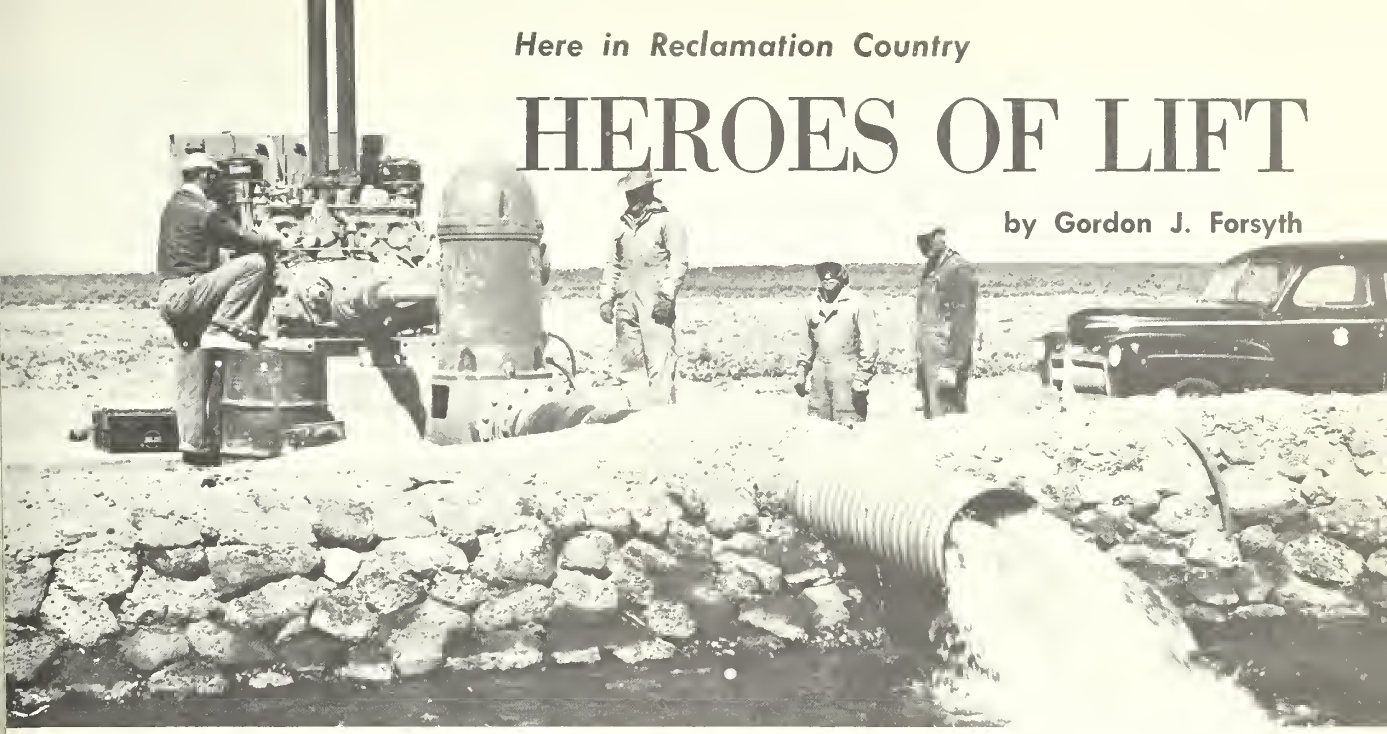
Volume 49, No. 4

OTTIS PETERSON, Assistant to the Commissioner—Information

GORDON J. FORSYTH, Editor

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. Use of funds for printing this publication has been approved by the Director of the Bureau of the Budget, January 31, 1961.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Price 15 cents (single copy). Subscription price: 50 cents per year; 25 cents additional for foreign mailing.



Here in Reclamation Country

HEROES OF LIFT

by Gordon J. Forsyth

THEY said it never could be done up here on this side of the river. Remember? Ten years go it was a parched sagebrush flat receiving less han 10 inches of rain a year.

Now, in place of that condition, the high land oasts active green farms of sugar beets, vegeta-les, seed and forage crops—48,000 pump-irri-ated acres of them.

A few months ago these servicemen veterans-urned-Idaho-farmers celebrated the 10th anniver-ary of the first homestead drawing for a poten-ally rich benchland farms on the Minidoka roject. Pumps using an abundance of ground-ater supplied the lifeblood for 637 farms. These rmers irrigated 72,154 acres of land last year d grossed a crops value of $10,309,000.

Actually, pumps are amazing machines and they ve taken an important part in reclaiming and nserving resources in the West. Many bench rmers thank pumps for their opportunity and ogress in farming.

When looking at the pump industry, one sees at modern pump designs and applications are gion. In this country alone there are several ndred pump manufacturers who produce mil-ns of them each year.

They range in size from units requiring flea-wer to drive them to ones absorbing several ousand horsepower, such as the Grand Coulee Dam units with their 390,000 horsepower and 450,000 pounds of weight. And pumps are produced in a great variety of designs and materials.

Even though pumps have their origin in a dim and distant past, it was just in 1840 that Henry R. Worthington invented his first steam pump for feeding water into boilers. Of this pump, we have many modifications today.

Hydropower Pump

Nearly all of the pumps 75 horsepower or over used on Bureau projects at the present perform the kind of job that is done on the Minidoka project. However, another kind also has received Bureau attention in recent years. It is the hydropower pump—used for pumped storage, a new frontier of technology. The latter are large pump-turbines which push great quantities of water up to elevated storage. When this water is released from storage, the pump-turbine is reversed by the water's returning flow and produces hydropower. This stored power is valuable to meet increasing peaking capacities that are required in some localities.

The Flatiron powerplant, Colorado-Big Thompson project, has three generating units which were

Above illustration shows an irrigation test at a pump in Region 1.

The old water-wagon way of carrying water brings back memories, and still is used.

placed in operation in 1954. One is a reversible pump-turbine unit with a generator capacity of 8,500 kw. Two units of 31,500 kw each are conventional turbine units.

Operated as a pump, the pump-turbine stores water in Carter Lake 55 feet up. During the off-peak hours of the nonirrigating season it stands ready to operate as a turbine to supply peaking power capacity to the power system, or to run water into the Horsetooth Feeder Canal.

Bureau engineer Henry J. Tebow, in *Western Engineer*, June 1962, wrote, "Installations of pumped storage date back as far as 1892 in Switzerland; Europe now has some 600,000 kilowatts of pumped storage capacity. The State of Connecticut seems to be first in North America in 1928 with its Rocky River plant of 50,000 kw." Today, there are seven other plants of this type in the United States.

Another Bureau installation of pump-turbines will make a debut between late 1964 and mid-1966 on the Federal-State San Luis Unit of California's Central Valley project. As Reclamation's largest units, these 8 machines will be capable of pumping water from a forebay to the higher San Luis Reservoir at the rate of 11,000 cfs, and also will generate a maximum of 360,000 kw of power on the return flow.

Investigations for pumped storage are being made at sites in Wyoming and Colorado, and the possibility of providing works for this dual capability at Grand Coulee Dam has been discussed in recent months.

Two-Pump Projects

In contrast with the Bureau's giant projects having numerous pumps for irrigation only, six Bureau projects have only two pumps and three have only one pump.

As the Lewis and Clark expedition made its way through Yellowstone River country in Montana in 1806, one of them scratched a memento on a prominent rock, Pompey's Pillar, overlooking a potential agricultural area. Later named Huntley project with 32,000 acres, the site was transformed into a development that Captain Clark might have anticipated. Five thousand acres of the elevated sections are productive due to two small semi-automatic irrigation pumps which require only an occasional checking by a ditch rider.

A few miles north on the same river, the Yellowstone, are two pumps of the Lower Yellowstone project. These pumps throw water into the Main Canal along side the Yellowstone and since 1909 they have irrigated land extending the 20 miles to the mouth where the Yellowstone meets the Missouri.

Even closer to the Canadian border and running parallel to it is the Milk River project and its twin-pump Dodson Unit. With extensive facilities it covers the 30 miles from Fresno Dam to Fort Peck Dam.

Further west in the mountain valleys of northern Idaho, the Bureau has established two smal projects with two pumps each which draw wate from picturesque Hayden Lake. Two of th pumps provide sprinkler irrigation to the 944 acre Dalton Gardens project, and the other tw irrigate on the Avondale project.

The sixth twin-pump plant in western Nevad was named in 1919 after the late conservation stal wart U.S. Congressman Francis G. Newlands o that State. Pumps are at the Lahontan Dam o the Carson River.

Pump near Sacramento, Calif., has a capacity of 49 cubi feet per second.

First water in a new waterway in Washington, 1948, is an occasion for cheers from many people.

Two of the three one-pump projects trace some of their history to prominent men. Famous fur trapper Jim Bridger was a frequent visitor of the Rocky Mountain Valley in northern Utah. Hyrum project was built there a hundred years later.

The first white man in the valley south of Salt Lake City was Provot after whom the city of Provo was named, and subsequently, the single-pump Provo River project.

In New Mexico, the Hammond project lands lie in a strip 20 miles long in the northwest part of the State. It is not known whether this project was named after a person named Hammond, but benefits of the project are shared by the towns of Blanco, Bloomfield, and Farmington.

Four-Ring Circus

The small projects have as much value per capita as the giant, complex projects. Individually, pumps are pumps, but if a person in a balloon in the air a score of miles could view the four pump networks in the great projects in Washington, California, Arizona, and Idaho, it would be like seeing a four-ring Barnum & Bailey circus.

In the northern circus ring at the Columbia Basin project, in addition to the largest 6 pumps at Grand Coulee Dam, this project has 325 others of a variety of sizes, kinds, and locations. Heavy metal shields cover the pump churning from view, but they are all pulling, pushing, and throwing water in every direction, resulting in an impressive irrigation concert. The project has a reach of over 125 miles and comprises a system of 282 miles of main canals and over 2,000 miles of laterals and drains.

The California ring is next, with the number of pumps performing totaling 326. An astronaut's eyeview of this 5-million-acre water development, the Central Valley project, if the pump's water shields were removed, would make the huge area look like a field of the "Dancing Waters." The dance floor of the fertile valley is 400 miles long and averages 45 miles in width. In 1958, the project water served 248,477 people, and it has a tremendous crop production and recreation record.

In the southernmost circus act, the Salt River project in Arizona, the performer is a lion tamer who uses the Salt and Verde Rivers as weapons to whip and cultivate the resisting desert wilds into a synchronized performance. In contrast to the surrounding parched desert, the tamed lands are in a verdant fan-shaped oasis marked with graceful palms and citrus trees. These lands are controlled by other such weapons as dams, wells, waterways, and the 257 pumps which raise the water and make it flow where it otherwise would not. With only 7.2 inches of rainfall a year, the pump system is busy pouring water to 452,000 people and irrigating 218,000 acres.

Back at another ring in the north, a high-altitude view would show the "Magician Act" along the Snake River. A complex of colorful streams like blue ribbons are attached to the Snake River stem and its adjoining runoff pools or reservoirs. By means of the Minidoka's 225 modern pumps, the ribbons carry water and produce miraculous green fields, other life and industry along its 300-mile length.

30–75—Pump Projects

The other 6 large projects operating 30–75 pumps are the Yakima project in Washington with 75; the Missouri River Basin Project in Nebraska, Kansas, North Dakota, and Montana, with 59; the Gila project in Arizona with 55; the

Klamath project in Oregon and California with 50; the Chief Joseph Dam project in Washington with 38; and the Weber project in Utah with 32.

Water pumping helped rank Yakima County, Washington, in 1958, as first among the 3,072 counties in the United States in production of apples, pears, and hops. Production also is high in flavorful cherries and other fruits and nuts. The fishing is gool along the Naches and Yakima Rivers where the fertile bottom lands and wild game attracted the cattlemen to stay in 1860.

A huge land area shaped like the stubby drumstick of a fried chicken is laying diagonally across the seven northeast reclamation States. This is the Missouri River Basin. Veins of water that show on a map of this chicken leg long have been probed by development-minded civil engineers and are rimmed with fertile land that Indians fought to keep for themselves in the 1860–70's. Now the canals, creeks, and rivers are veins dotted with two-score pumping units that pull the treasured water onto lands before it is returned to the great artery, the Missouri.

Flavoring the meat at the top of the MRB drumstick is the fresh water pumped from the head of the Missouri on the Helena Valley Unit in Montana. The Last Chance Gulch gold strike in 1864 caused a boom in this area.

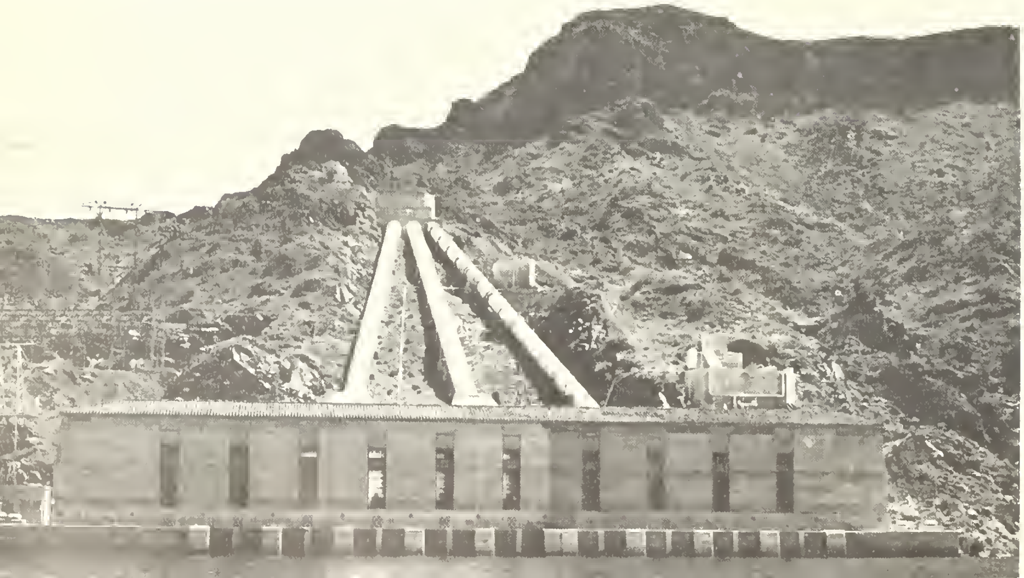
Joining in this upper tip development is water from the three pumps of the Crow Creek Unit irrigating 3,400 acres of Montana crops valued at $302,400 per year. Reclamation construction was completed during 1952–54.

The six pumps and companion structures at Anchor Dam on the Owl Creek Unit irrigate high mountain lands of Wyoming that produce mainly

Pump at Fort Morgan, Colo., is used for irrigation.

livestock. A short distance downstream from Owl Creek, the Hanover-Bluff Unit pumps aid in watering more Wyoming crops. In northeastern Montana, 2 Savage Unit pumps now irrigate a dry farming area. Potatoes and other cash crops are grown in rich bottom and bench land with the help of three pumps of the Fort Clark Unit, North Dakota. Along winding Heart River are 23 pumps supplying lifeblood to more than 73 small farms and the town of Mandan on the Heart Butte Unit, N. Dak.

The only pumps remaining in Reclamation's chicken-leg basin take up a sizable bite located in the small south end. This 38,800-acre piece, the MRB's Bostwick Division, straddles the border of Nebraska and Kansas, and includes six pumping units.



Supplying water to southern California is this Parker Dam pump of the Metropolitan Water District.

Pumped water opened this 10 acres of land for cultivation on the Yakima project in 1947.

In western Arizona, the Gila project collects only 3.5 inches of rainfall a year, and it is considered as valuable farmland because of its 253–348 days' annual growing season. Multiple crops of alfalfa and some other forage crops can be harvested each year. Making irrigation history, Indians were found irrigating crops near the mouth of the Gila River when Alarcon discovered the Colorado River in 1540. By pumping and diversion of 134,500 acre-feet from the Colorado River, Gila Valley has been kept in production. A salt problem and a seasonal flood problem is in the process of being overcome through drainage works and river control features.

The Klamath project receives but little rainfall each year. However, because of the prevalent natural storage formations and the construction of Reclamation features, it is profitable farming country. In addition to its 50 pumps, the Klamath project makes use of 8 dams and water carriage structures located 38 percent in California and 62 percent in Oregon.

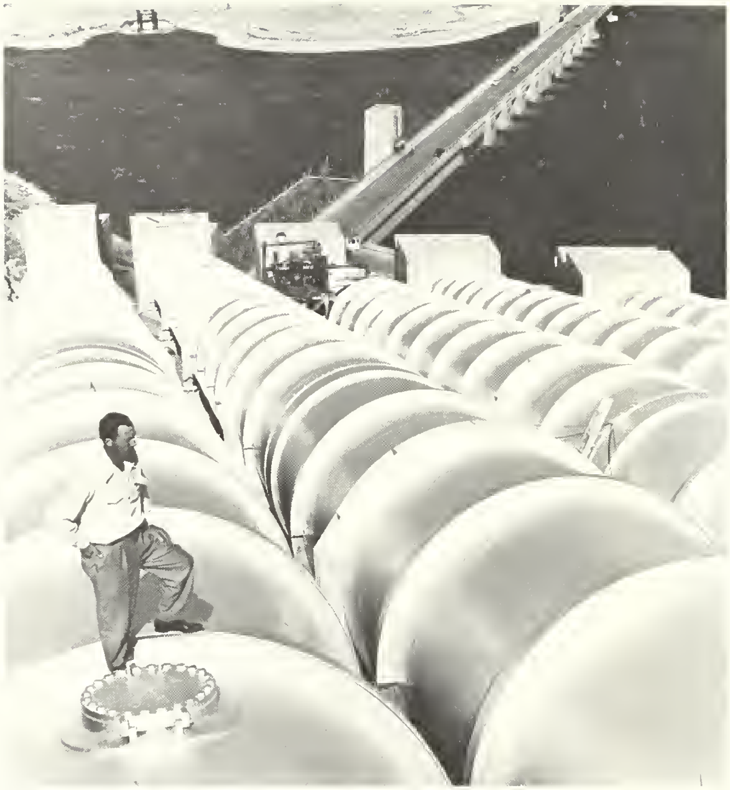
Most of the 38 pumps on the Chief Joseph Dam project in central Washington are used on a special distribution system, with water pumped from the Columbia River for sprinkler irrigation. The first agricultural enterprise in the area was cattle raising and it is still an important product, as is apples, vegetables, and pasture. Last year new pump installations provided for more sprinkler irrigation and construction is still underway for another pump unit to be completed next year.

Twenty-four of the 32 pumps on Utah's Weber project were installed in the past 5 years and it has received other extensive development since 1952. In 1847, Mormon pioneers arrived and in the following year they drew Weber River water for irrigation and domestic uses.

Little Precipitation

The areas where pumps are probably the most precious are the places where there is little or no precipitation the year around. Five projects with an intermediate number of installed pumps claim 10 or less inches of precipitation annually, but the

Cased tomatoes harvested on the Central Valley project.



Standing on a 12-foot water pipe extending from pumps at Grand Coulee Dam is a man whose farm was made possible by pumped water in 1952.

lands bear unique American products. For example, on the All-American project south of Hoover Dam, Nev., 19 pumps are in operation, rain or snow are rare, but 90 percent of our Nation's dates are raised there, and 155 cfs is carried to the city of San Diego, Calif.

Such contributions also are made on the Crooked River project in central Oregon with 7 pumps, the Grand Valley project in Colorado with 5 pumps, the Owhee project on the border of both Idaho and Oregon with 22 pumps, the Lower Rio Grande Rehabilitation project in southern Texas with 3 pumps, and the Yuma project in Arizona with 16 pumps.

Pressure is forced for sprinkler irrigation on Michaud Flats project and Rathdrum Prairie project, both in Idaho with four pumps each.

Economy was stabilized in the areas of four other projects which have varied but interesting history. These include the Buffalo Rapids project in central Montana with 14 pumps, the Buford-Trenton project in North Dakota with 3 pumps, the Boise project in Idaho with 9 pumps which is celebrating its centennial year (see p. 102), and the Washita Basin project in Oklahoma with 9 pumps.

Two of the Bureau's outstanding projects at the present are on the throne of values returned. Both projects, nearly adjacent to each other in the Los Angeles area of California, supply great quantities of municipal water, and recently have been considerably urbanized. However, the Ventura River project with its 14 pumps and 195 farms has a gross crop value per acre of an almost unbelievable $806 annually. It has a lengthy 11-month growing season. The other, the Cachuma project, is second to the Ventura, has 4 pumps, 580 farms, and an annual gross crop value of $707 per acre.

Water pumps on these 35 Reclamation projects perform heroically for the people they serve. There are 1,605 of them ranging in capacity from 75 to 65,000 horsepower each.

The origin of pumping water has been lost in antiquity. But without a doubt the pump is one of the most prized and important of all of men's machines. Whether it is a bucket on a wooden lever operated by an ancient Egyptian, Chinese, Indian, Greek, or Roman, or a modern automatic turbine operating alone in wilderness country, this device is a hero of water reclamation.

# # #

RAJASTHAN

it will bloom again

by John K. Black
Division of Foreign Activities
Washington, D.C.

AS a surveying party worked its way far out into the Rajasthan (pronounced Rau-jas-tan) Desert, a young engineer saw a familiar-shaped stone protruding from a sand dune. The party came up and shoveled out around it. Sure enough, here was an ancient miller's stone. It was round, about 4 feet in diameter, a foot thick, and had a hole in the center for a turning hub.

The group of men on this Western India desert was made up of Indian engineers who were engaged in surveying a canal centerline through more than 400 miles of sand dunes for the proposed Rajasthan Canal.

It was a curious experience—their finding such a heavy implement out here, hundreds of miles from a wheatfield or river. However, the wheel was there and it was evidence that a river had oncce flowed through the area, a community of people had been there, and they had ground wheat into flour for food near that spot perhaps thousands of years before.

Both history and legend tell the story of the ancient and sacred river called the Saraswati that had flowed there. Far-reaching changes in the great Indo-Gangetic plain dried up this and other rivers, and changed the fertile plain into a desert wasteland. In generations past, kings and rulers dreamed of bringing back the river and making the desert bloom again. But not until this decade did the dream start to come true. This year, finally, water came into the first completed sections of the Rajasthan Canal to Mile Post 46.

Oscar Rice, Vaud E. Larson, and the writer, members of the Bureau of Reclamation team, were taken into the great Indian desert in May to observe how the people of India go about building a canal. The United States has a financial interest in the development. Their first view of a completed section was near the resthouse, or construction camp, at Lakhuvali. The day they arrived it seemed that a "camel rodeo" was in progress in the camp. Camels draped with colorful blankets and saddles were converging upon the resthouse from every direction.

A Camel Ride

An event was beginning. It seems that during the morning, Mr. Rice, the team leader, had casually mentioned to Mr. R. N. Chowdhary, Chief Engineer, Rajasthan Canal project, the team's host, that he would like to take a ride on a camel while he was in India. So, Mr. Chowdhary, without further word to the team, telephoned ahead

Like building pyramids of old, this huge canal project requires infinite repeating of laborious tasks.

R. N. Chowdhary, Chief Engineer of the Rajasthan Canal project (left), stands with author J. K. Black. A local farmer on the camel is hauling straw.

for one of his staff to see if he could "round up a camel" so that the engineer from America could have his ride.

So here was the response. There were racing camels, bucking camels, big and little camels, and mean camels blindfolded so that they couldn't bite an unwary target with their sharp teeth. Yes, and even camels tame enough to be ridden by ex-cowboys from the West. So the new arrivals had their camel rides. They also watched races, saw bucking camel riding, and before departing, drank tea and soft drinks with the Indian engineers. Also before leaving, the boy driver of the meanest camel insisted upon his picture being taken alone with his famous black steed. Needless to say, the Americans willingly clicked their cameras of him.

Loaded into jeeps, the team went a short dis- tance to Rajasthan Canal. Its high embankmen was viewed from the resthouse one-half mile away

At the project, it was observed that the Indian are constructing the canal so that the bottom wherever possible, will be at ground level. O either side, they pile embankments approximatel 30 feet high with earth carried, for the most part in head baskets out of rooms extending back 20 feet or more from the toe of each embankment Driving onto the service road, water was see flowing in the finished section of the canal. I wasn't a full head but it was sufficient to giv proof that at last water was flowing once agai near where the sacred Saraswati had been. Th water was from the Bhakra irrigation system i the northeast and flowed out to the constructio area to be used by workmen and their familie cattle, donkeys, and mules.

Construction activities were in evidence fa ahead in the desert. Along the way there we 12,000 men and women engaged in various co struction activities. One tall stately woma dressed in bright colors and with golden bracele on her arms stepped gracefully up the embank ment carrying approximately 60 pounds of bric in her head basket. Bricks are being used in t canal's double lining. Her task can be best a preciated by considering that the canal will 25 feet deep, 118 feet wide at the bottom with $1\frac{1}{2}:1$ slope. The main canal will carry 18,500 cf which measured by western U.S. rivers is a migh stream.

Muscle Labor

Also in the construction area, a continuous li of men and women were seen carrying earth o of the borrow area in their head baskets. Th averaged 100 cubic feet per person per day. F distances of over 200 feet, donkeys are use They are herded back and forth from the loadi areas to the top of the embankment. A sm donkey carries as much as a man or woman, whe as a mule carries up to 400 cubic feet.

With temperatures ranging up to 125° and t air almost constantly filled with blowing dust, on hardy, determined people could undertake and co struct a canal system some 400 miles through desert. But it will irrigate $4\frac{1}{2}$ million acres land when finished.

Continued on page

FEES FOR FUN

INCREASING numbers of people enjoy the fun of boating, fishing, and picnicking on Reclamation lakes. But paying fees for using the boat ramps and other facilities at the lakes is another matter. "After all," many people reason, "these recreational areas are built with public money. Why shouldn't we use them free of charge?"

Boat ramps and other popular facilities for outdoor recreation require a provision for operation and maintenance costs. The need for cleanup and repair work at the areas is well understood.

There is also another twist to the matter of fees for fun. It costs money to collect the fees. Records show that the cost of making the collections sometimes almost equals the amounts collected, leaving very little to help pay maintenance costs.

When it was necessary for the Bureau to take over responsibility, on an interim basis, for the recreation area on Rockport Lake, Utah, that office staff tried a new method. They started a voluntary donation of fees and it works.

Rockport Lake is a convenient 40 miles east of Salt Lake City; in a season, it will attract large crowds of people on evenings and weekends.

A sign and a strong collection box were placed at the entrance to the lake area, called Wanship Reservoir, a feature of the Weber Basin project.

The sign asked visitors to deposit 50 cents per car if they used firewood, campgrounds, picnic facilities, or the boat launching ramp. The collection box is unattended, except that the proceeds are called for each day by the Bureau's powerplant operator at Wanship Powerplant. He is bonded to perform this collection function.

Last season, a total of $1,720 was collected. Cost of making the collections—practically nothing.

Another important item was reduced to nothing—that is *complaints*. People seem to like the voluntary donation system. They like to be trusted.

The WEP office feels it is a good method of solving a tough public relations problem. = = =

Recreation at Wanship Reservoir, Utah.

705-910 O - 63 - 2

Aerial Application of Chemical Monolayer Studies at Elephant Butte Reservoir Are Reported

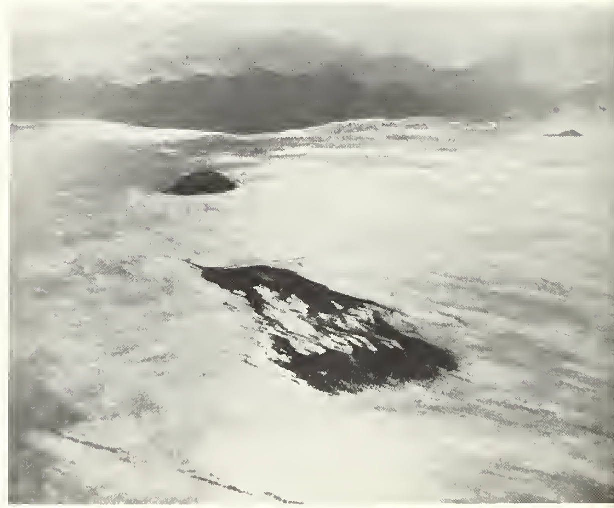
A monolayer behavior and aerial application study was performed on Elephant Butte Reservoir, N. Mex., during September and October of 1962. The study was conducted in preparation for a future large-scale field test to be carried out on this reservoir.

This will be one of a series of large-scale field tests performed by the Bureau of Reclamation in its investigation to determine practical means to reduce, through the use of monomolecular films, the loss of a dwindling water supply from evaporation. By the study at Elephant Butte, it was demonstrated that a monomolecular film could be applied and maintained on a large, long narrow reservoir by use of an aircraft for the dispensing of monolayer-forming material under favorable conditions.

Five aerial applications were made to two distinct portions of Elephant Butte Reservoir described as the lower and upper basins which comprised an area of about 7,000 acres out of a total of 8,250 acres of the reservoir at the time of treatment. (Total reservoir area and capacity is 36,600 acres and 2,206,800 acre-feet, respectively.) Three aerial applications were made applying a molten liquid form, and two applications were made applying a dry powdered form of an evaporation retardant.

The monomolecular film was observed for 2 days following each application in which a record was kept of the film coverage and its degree of compression determined by the use of indicator oils. The coverage ranged from 100 percent immediately after application to near 0 percent on the second day after application, with nearly all the attrition attributed to blowoff by the wind. In general, the higher winds occurred during the afternoon. The film showed an ability to recoup and regenerate itself when the wind was more favorable.

Results of this field study showed that if a day-to-day application was made on this reservoir, a large coverage could be maintained in favorable winds that should result in considerable saving in water normally lost through evaporation.



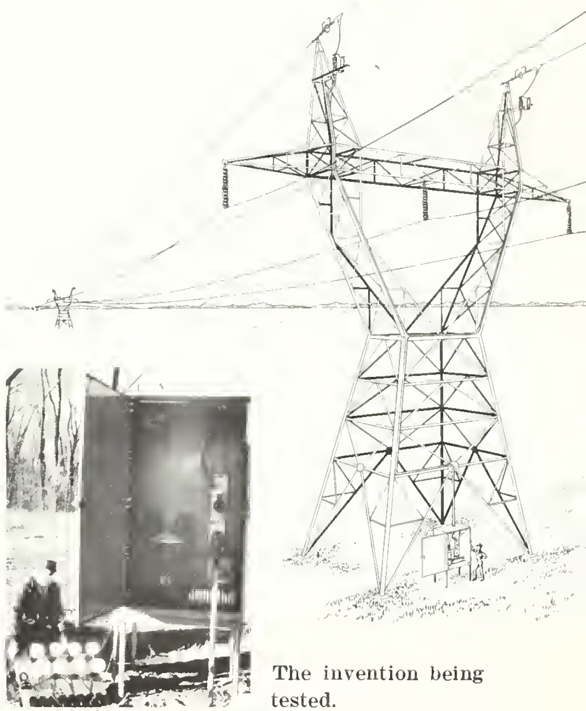
A large chemical monolayer shines in the sunlight on Lake Mead above Hoover Dam—antievaporation testing.

The use of aircraft proved to be an effective and expeditious method of applying the monolayer forming material. The spreading rates of both forms of the material in powder and molten form appeared to be about equal after they once had appeared on the water surface as a film. However, the dry powder was less difficult to handle and required simpler dispensing equipment. As this was a preliminary study of monolayer behavior and of aerial application covering a short period of time, no evaporation-saving determinations were involved.

Aerial spraying equipment was developed by Utah State University under research contracts with the Bureau of Reclamation. Reeder Flying Service worked with Utah State University in the development of this equipment. # # #

Taken from summary and introductory statements in *Aerial Application Technique Development and Monolayer Behavior Study, Elephant Butte Reservoir—1962*, March 27, 1963, 165 pages. Available at the Office of Chief Engineer, Denver, Colo.

A power "*FREE LOADER*" is invented



The invention being tested.

THE Office of Chief Engineer, and specifically John E. Skuderna, an electrical engineer of the Design and Research Center at Denver, has invented an electrical device which will furnish inexpensive auxiliary power from high-voltage transmission lines. The device makes it possible to obtain this power in isolated areas for aircraft warning lights, microwave relay stations, and other forms of powered communication equipment, and to do it safely.

It has been nicknamed "Free Loader" because any area traversed by a high-voltage, cross-country transmission line can become its "home."

The accompanying picture and drawing illustrates how the "Free Loader" is set up. It takes advantage of the electrostatic field heretofore unused for auxiliary purposes, which surrounds the conductors in high-voltage transmission lines.

As against conventional methods of directly tapping high-power, 230,000-volt transmission lines, each new-type installation will save $5,000. On the new 345,000-volt lines, economic benefits would be even greater.

Effects of the device on the performance of transmission lines are negligible. On such lines which transmit a nominal 150 million watts, the device will collect only 1,900 watts. This is the amount of power a kitchen toaster uses, but it is entirely adequate to power warning lights and radio relay equipment in remote areas. Components of the invention are standard and easily obtained.

A standard line of this type has three tower-supported conductors plus overhead ground wires. The circuit, functioning in the electrostatic field existing between the conductors and one ground wire, capacitatively collects 60-cycle power which is reduced from 230,000 volts to a 120-volt standard house service.

At one point in the development of the new instrument, a 30-order equation with 30 unknowns was fed into a high-speed digital computer. The problem was so complex it took the computer a half hour to answer. # # #

little creatures CLOG BIG CANALS

SMALL water creatures are causing some mighty big problems in Reclamation's Delta-Mendota Canal in California.

Problems first came to light as the Bureau began studies to determine how much extra water the canal might be able to carry when the San Luis Unit of the Central Valley project goes into operation in about 5 years.

Since 1951 the Delta-Mendota Canal has carried water 117 miles along the San Joaquin Valley, but it never had been put to its maximum use of 4,600 cubic feet per second.

In order to prove the actual capacity of the canal, Bureau engineers turned on all six pumps at once at Tracy Pumping Plant.

They were shocked at the results. Within hours the canal was overflowing. Further tests showed that only five pumps could maintain a near-capacity flow in the canal. Almost one-sixth of the canal's effectiveness had been lost. Something was wrong somewhere.

Engineers rechecked the construction data on the canal, and no errors were found to account for such a loss of flow.

The Delta-Mendota is part of the Central Valley project which is a joint Federal-State facility now under construction by the Bureau near Los Banos. Operation of the unit will depend upon the use of a wintertime surplus of water being lifted from the Sacramento-San Joaquin Delta by the Tracy pumping plant and then being carried southward through the Delta-Mendota Canal and pumped into the San Luis Reservoir.

In attacking the canal's loss of flow problem, engineers rechecked the construction data and found no errors. They reviewed the design of the pilings on the many structures crossing the canal, and planned to check the possibility of abandoned automobiles and junk that might be on the bottom, blocking the flow.

Dewatered in 1961

In the winter of 1960–61, while the canal was idle, a 35-mile reach of the Delta-Mendota was dewatered. No abandoned automobiles were found and only a few empty safes and coin telephones stripped by burglars were removed. These would not have caused the flow problem. Then the causes were in evidence. They were bars of clay, silt and sandy sediments on the bottom. They ranged in thickness from a few inches to 2½ feet and sometimes more than a mile in length.

But the more complicating factor was that all of the bars were permeated with millions of Asiatic clams—live ones near the top and dead ones below 2–3 inches. Also along the walls and on the piers of structures was a crusty layer of aquatic life.

Men inspecting clam bed sediment on the bottom of the canal.

Once the canal was dewatered, the prime concern was to get it clean again as rapidly as possible. For 45 days, there was digging, scraping, and hauling out of the dirt and debris.

Cleaning up of the bars on the bottom posed no great problem. The deposits were easily pushed to the side of the canal by front end loaders and road graders, then removed by drag lines, and appropriately, clam shell buckets on long booms.

Crusty scales of the acquatic animals clung to the canal walls in defiance of efforts to remove them. Finally with some success, they were scraped off by putting weights on sections of chain-link fencing and dragging them along the sides. After five passes, the major portion was clean. When the bridge piers were cleaned of growth and streamlined to provide less resistance to flow, water was reintroduced into the canal.

The following summer it as discovered that the cleaning program had increased the flow by 5 percent. Engineers lay the remaining loss of flow to shortcomings of existing formulas for predicting flow in large, flat-grade canals such as the Delta-Mendota. This already has resulted in a change of design in the San Luis Canal now under construction and probably will lead eventually to the development of a new formula for such canals.

Gains made on the Delta-Mendota were only moderately encouraging to engineers because the cleaning had been a time-consuming and costly process. Draining for this kind of mechanical canal cleaning also would cause a problem when the San Luis Unit is completed. As the whole unit begins operation, the canal can no longer be shut down for maintenance and repairs during the winter.

50,000 cubic yards of clam-bearing sediment were removed.

Corroded safes, cash registers, and other machinery were removed from the canal during cleaning.

Objective Study

In 1962, 75 miles of the canal was dewatered and a comprehensive study was made to learn more about the composition of the crusts; also how they got there and where they came from.

The program included a general inspection, mapping of all bars, and careful geologic sampling. All steps of the investigation were recorded on black-and-white photographs, colored slides, and motion picture film.

About 50,000 cubic yards of sediment were removed from the bottom. Clams were wedged together at a rate of as thickly as 60 per cubic inch. As sediment came into the canal from drains and from erosion of unprotected embankments, the clams had accumulated and started to build up. Organic particles that are pumped in with water from the delta served as food for the aquatic animals in the canal.

This study is not yet complete but enough of its is to show that the crusting along the sides of the canal is composed of amphipods and bryozoa. The amphipods are minute and shrimplike, with glands which produce a kind of "natural glue" which, traps particles of dirt suspended which traps particles of silt suspended in water. Amphipods mix with the bryozoa forming mosslike colonies. The mixture of the amphipods, the silt in the water, and the bryozoa result in a tough clinging scale that resists removal efforts.

Other growths on the walls, piers, and siphons were found to be fresh water sponges.

Research Findings

Engineers believe that elimination of the siltation problem would undoubtedly cause a decrease in the clam problem, but the food presently consumed by clams might then be consumed by some other organism—probably the crust-building type. And it was found that decreasing the number of fish in the canal magnified the amphipods. The latter are excellent fish food. Fewer fish returned after the 1960 work which seemed to have caused a 200-percent increase in amphipod crusts and a 400- to 500-percent increase in sponge coatings.

Bureau officials feel certain that the solution to this problem is not to be found entirely in mechanical controls. Nor do chemical controls offer much hope, since the water is used for domestic, agricultural, and industrial purposes.

The Bureau is now exploring the possibility of biological control of the organisms, realizing the dangers of action which disturbs the balance of nature.

Therefore before any other form of life is introduced into the Delta-Medota, more studies and experiments will be conducted. Eventually the Bureau expects to eliminate the millions of little creatures which are causing a reduced flow in Reclamation's important water-carrying arteries. # # #

SHADES OF JULES VERNE . . .

Balloons in Glen Canyon

by W. L. Rusho, Region 4

ONE day in December 1962, a group of awed tourists standing on Glen Canyon Bridge were being treated to a new spectacle. They could have expected to see heavy construction, massive buckets swinging, and far away workmen walking on the wet concrete of famous Glen Canyon Dam like so many ants.

But they saw something different. Moreover, it was on the downstream side of the bridge rather than upstream at the dam. Seven hundred feet below these visitors, on the canyon floor, was a long, silvery plastic balloon shining in the bright Arizona sunshine. For about 2 hours it slowly and silently grew larger as men worked intently around its base.

Suddenly the balloon began to rise. Gathering speed, it ascended straight up from its moorings and passed the marveling spectators.

They could not see all. But valuable scientific instruments were installed in the large gondola which hung from the 100-foot-long polyethylene balloon.

Within minutes the giant balloon became only a brilliant spot in the blue sky. Without sound, it had risen to great heights, and a thinning crowd remained to follow the sight of the speck in space.

Hours later, when darkness had fallen over Glen Canyon Dam and the nearby town of Page, Ariz., the balloon had floated 100 miles away and over 100,000 feet high carrying its experimental instruments.

Glen Canyon had seen its first balloon launching but not its last.

This initial balloon, as well as a few that followed, were designed to set the stage for launching some of the largest balloons ever sent aloft. And Glen Canyon was determined as one of the most satisfactory wintertime sites for the exacting work.

An NCAR Project

The National Center for Atmospheric Research discovered that during the winter, surface winds were a favorable zero, or nearly so, in the now waterless section of the canyon, and that the wind pattern in the upper atmosphere 50,000 to 100,000 feet up was also favorable. It is calculated that balloons launched here would land in Oklahoma, a good recovery area.

Large tube attached to the side of the balloon carries helium to inflate the balloon.

Balloon with instrument-laden gondola rises in view of Glen Canyon Dam.

Because of the east-to-west surface winds in the summer, launchings during that season are not planned from the canyon. At least 2 hours is required for the delicately thin balloon to inflate, and it is sensitive and vulnerable to even a slight surface wind.

Summer launchings will take place in Palestine, Tex., where any adverse wind conditions can be overcome by a windshield constructed several hundred feet into the air.

Balloons have been inflated in holes in the ground. This was done in open pit mines in Minnesota.

The NCAR plan of introductory launchings at Glen Canyon, after Reclamation's approval, was to contact its parent organizations, the 12 universities that created it in 1960. The Center also advised the National Science Foundation, the Government agency that provides most of NCAR's funds, of the Glen Canyon plans. Intentions for the first operation called for the successful launching and recovery of small balloons, capacity 1,125,000 cubic feet of helium.

The major experiment, officially called Polariscope, which is planned as a possibility for next fall will consist of transporting a 28-inch telescope, a device called a polarimeter, and various related equipment to an altitude of 100,000 feet, above most of the earth's atmosphere. At that point the telescope will automatically lock on the planet Venus. The telescope would then obtain and transmit information concerning the atmosphere of Venus to ground stations via television. The Polariscope experiment requires years of preparation, countless experiments, and precise matching of the finest quality components. It is being devised and the experiment will be conducted by Dr. Tom Gehrels and his staff at the University of Arizona's Applied Research Laboratory.

Venus Atmosphere

Why should a telescope be transported above earth's atmosphere in order to observe Venus? The answer is that our own atmosphere grossly distorts the light coming from stellar and plane-

tary bodies in outer space. The familiar twinkling of stars is just this type of distortion. Above the atmosphere, stars do not twinkle and scientific readings are found to be more accurate.

The use of rockets to transport the telescope above the atmosphere is ruled out because they move out of position too quickly. Also the instruments are extremely delicate and could be broken by rapid acceleration. And very important is the much greater cost of rocket launching over that of balloon launching.

Some problems were encountered in choosing the best location on the bottom of the steep-walled canyon. Of two possible launching sites, the pumping plant for supplying water to the town of Page located in site of and about a mile downstream from the dam finally was considered best. This site is near a Jeep-type approach road down the cliff and would not be disturbed later when releases are made for operating the powerplant at the dam.

Conditions also were favorable at the area of the downstream coffer dam which served to prevent the river from backing into the dam construction area. This one could not be permanent, but NCAR's Al Shipley, Bob Kubara, and their men began preparations there to make the first experimental launching. Its excellent conditions would make the first trials easier with less risk to their sensitive materials.

Test launchings provide valuable experiences with wind as well as mechanical circumstances. And this research organization has had troublesome experiences. During inflation of two of the early tests, gusty thermal winds came up and ripped the balloons apart. Another balloon was successfully launched, but it turned out to be a "leaker" and settled on the nearby Hopi Reservation.

Found by a Sheepherder

Luckily, a Navaho sheepherder stumbled onto the gondola of one of the first balloons perched on a remote ridge. He reported his find to the nearest trading post and received his cash reward from the NCAR.

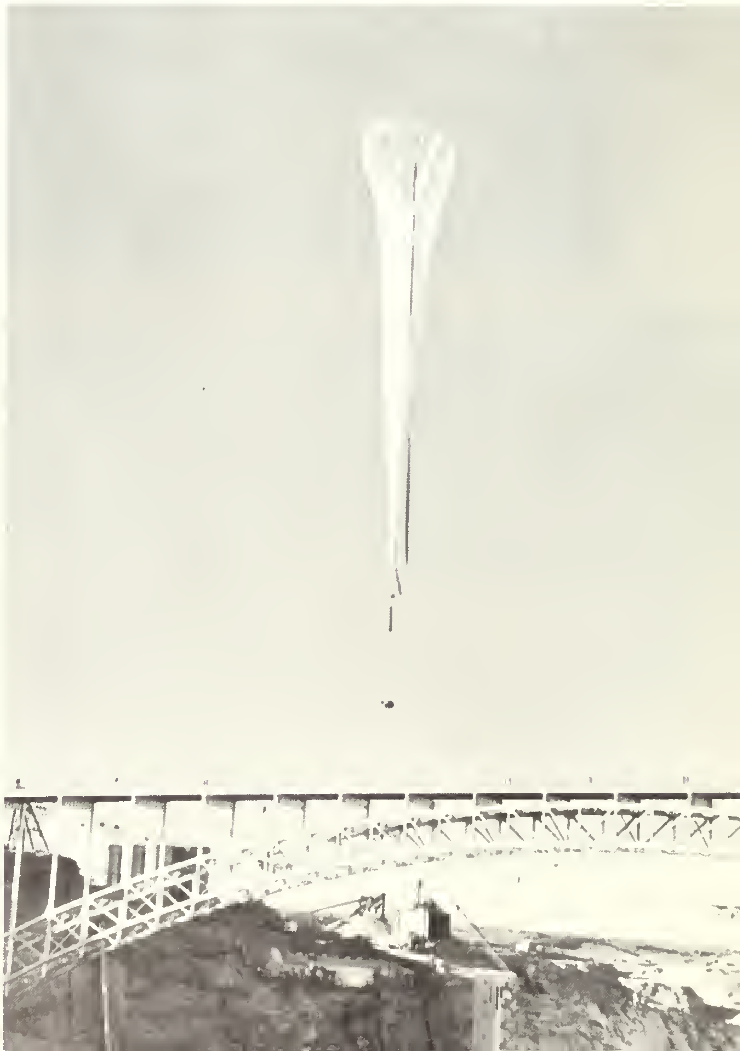
One problem balloon descended into a cornfield in Colorado near the Kansas border. On its way down, it had broken the powerline supplying the small city of Stratton, Colo. Nonetheless, it was an important flight, and in some respects, a successful one.

Al Shipley says that difficulties are expected. "We are getting acquainted with the surface wind patterns and are bound to make some miscalculations. By next year, we will know much more about the daily and hourly wind shifts at Glen Canyon. Actually, this canyon has some of the best winter wind conditions to be found

Meanwhile the University of Arizona is proceeding with ground experiments on the Polariscope, and preparing for its flight into the stratosphere. When inflated with its 10 million cubic feet of helium, the balloon will be 600 feet long and reach almost to the rim of Glen Canyon during inflation. The launching of this heavy package will undoubtedly be an important scientific effort and adventure for this country.

Already the NCAR is talking about launching a balloon holding 20 million cubic feet of gas sometime in the future. And Glen Canyon may launch the monster and become a major balloon-launching site—which would be a major scientific activity made possible by the construction of Glen Canyon Dam in the amazing canyon of the Colorado River.

# # #



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Irrigation Set the Stage for BOISE CENTENNIAL

CENTENNIAL celebration for the city of Boise and the State and Territory of Idaho, as well as the pioneer construction of Arrowrock Dam, was held in early July with participation by pioneer residents, the present population, and Region 1 staffers.

Once the construction and contract bosses of the Morrison-Knudsen Co. which constructed Arrowrock Dam, and now content in this photo to receive parade plaudits of cheering crowds, are shown the two men in person. Sitting luxuriously in the back seat of a well-preserved Model-T Ford, they are—Harry W. Morrison, cofounder of M-K Co. and now chairman of the board, who started his career as an employee of the Bureau of Reclamation, and R. J. Newell, a contemporary who started his Reclamation career in 1903. The gentleman in the driver's seat is Percy M. Pinder who started with M-K Co. driving a team on canal work in the Boise Valley. He has been with the company, for 48 years, the last 40 as chief warehouseman.

Not just incidental to this event is recognition of the 99th year (1864) from the date of the first water right to old Fort Boise.

For his chairmanship of the Centennial Pageant and for other community leadership, Regional Director Harold T. Nelson received the Civil Servant of the Year Award by the Boise Chamber of Commerce. Approximately 50 other regional office staffers served on celebration committees, acted in the pageant cast, wore pioneer costumes, and the men grew beards and mustaches. # # #

SOIL CEMENT PROTECTION PAYS

This is the last in a series of articles on technical leadership introduced by Reclamation Commissioner Floyd E. Dominy in the February issue.

MORE than 13 years' research by the Bureau of Reclamation on the problem of protecting earth dams is paying big dividends in the Great Plains today.

These dividends for research are saving about $1,343,000 on the low bids for protective facings on the Merritt and Cheney Dams in the Missouri River Basin. These savings were made possible by the use of soil-cement in place of riprap which protects the sides of earth dams from erosion, wave action, and other adverse elements.

Riprap is the conventional hard, durable rock protection placed over the slope of earth dams to depths of 3 feet or more. In the Plains area, rock of this description is not readily available.

Soil-cement on the upstream face of a dam consists of soil or earth, portland cement, and water mixed in a stationary mixing plant, and placed for compaction. Its external appearance is that of a terrace of steps.

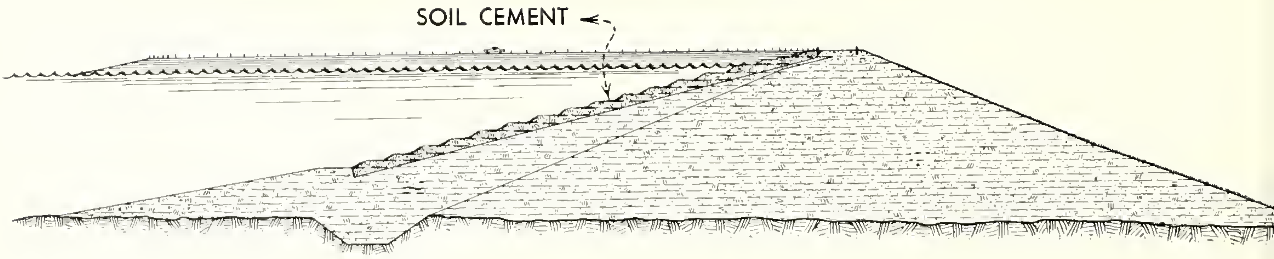
A shortage of appropriate rock for riprap presented itself in the planning of Merritt and Cheney Dams, to the extent that four of the seven contractors making bids for construction of the face of Merritt did not enter bids on the basis of protection by rock covering. Four of the eight bidders for Cheney failed to enter riprap bids.

For many years, the extreme cost of transporting tremendous amounts of rock long distances inflated the cost of construction in the MRB. In one such instance, it was necessary to haul material by train and truck 250 miles. This was at Bonny Dam in eastern Colorado where 500,000 tons of rock for riprap was required. It was brought from Golden, Colo., by truck, transferred to railroad cars at Boulder, shipped to Burlington, and finally trucked to the damsite.

In 1950, the Bureau launched its drive to solve this problem. Extensive explorations and tests of materials were undertaken for suitable earth dam protection.

Following laboratory tests, an experimental earth embankment was constructed using soil-cement at a typical problem site. Location was Bonny Dam's reservoir in rock-hungry eastern Colorado. Bonny was selected because it was within a reasonable distance from the laboratories in Denver. A test embankment was constructed away from the dam itself and positioned for exposure of maximum wave action, freezing and

Truck at left is dumping plant-mixed soil-cement at Sanford Dam. Water is added over completed layers from the truck at right.



The addition of soil cement to the facing of Merritt Dam is shown in this artist's cutaway drawing.

thawing, wetting and drying, and other erosion conditions.

For a 10-year period the study went on to determine the behavior of the surface. Minor repairs were required during the early periods of the test, but not of a nature as to question the value of the material or techniques.

Following the weathering and erosion cycles, deterioration of the surface was insignificant. Even ice washing up and down the slope failed to cause noticeable damage. It was then concluded that a stable, wave-resistant facing for earth dams could be constructed of soil-cement using conventional methods for placement.

The cost of testing this new building procedure reached about $80,000, an amount which has been saved many times where soil-cement has been specified. And on the basis of the research done, other tests of a similar nature can be conducted at nominal cost.

Each new use of soil-cement requires careful analysis of soil available, and the ratio of cement to soil or sand will vary from 9 to 14 percent by weight of dry soil. Current construction methods have been somewhat changed from the testing at Bonny Dam where placement of the dry materials was made on the spot before mixing and wetting. Now, the established procedure is to use a stationary mixing or batching plant to assure a complete and uniform mix.

The step-by-step procedure is as follows: (1) Mixing of soil, portland cement and water; (2) placement, spreading, and leveling of soil-cement in layers; (3) compaction to required density; and (4) addition of water or cover as required to maintain moisture content during the curing period. Layers are added to achieve the desired thickness.

The success at Bonny first opened the way for the use of soil cement at Merritt on the Snake River. It is a rolled earthfilled dam with a structural height of 140 feet and a crest length of 3,100 feet. Approximately 51,000 cubic yards of soil-cement applied at a depth of 24 inches will protect the surface. A savings will be about $643,000 over the cost of rock riprap.

This material also was used at Cheney where the zoned earthfilled structure rises 86 feet above the bed of the Ninnescah River 25 miles west of Wichita, Kans. The crest of the dam stretches 24,500 feet, creating an upstream slope requiring 180,000 cubic yards of soil-cement. Here, the use of the material and technique effected a savings of nearly $700,000.

The new procedure and basic mixture also were followed in the recent placing of a soil-cement lining in the temporary stilling basin at the Bureau's Sanford Dam being constructed on the Canadian River near Amarillo, Tex. The earth-stilling basin, lined with 5 feet of soil cement, is used to calm the river's flow where it is being narrowed for construction of the dam and will be in use for approximately 2 years.

Wider use of soil-cement will come; already, the State of New Mexico is realizing the benefits of Bureau research. Representatives of the State and the engineering firm contracted to build Ute Dam near Logan, N. Mex., visited the Bonny Dam test section in early 1962. The men carefully studied the test records and, following further consultation with the Chief Engineer's Office, soil-cement was specified for Ute Dam.

With the planning and construction of each new Bureau project, more and better data are available to make it possible to build better at less expense. Meticulous testing of new ideas and improving on old ones have achieved the forward steps in this field of construction. # # #

KEY PERSONNEL CHANGED

W. P. Kane Appointed Assistant Commissioner

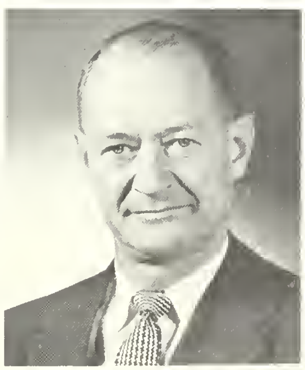
Wilbur P. Kane, formerly Assistant Director of the Division of Budget of the Department of the Interior, has been appointed Reclamation's Assistant Commissioner for Administration, taking office on August 27.

Mr. Kane succeeds W. D. Denit who recently was named Director of the Departmental Office of Survey and Review. He will have responsibility for fiscal, personnel, and general administrative services of the Bureau under the direction of Commissioner Floyd E. Dominy.

Mr. Kane is a career employee who has spent his entire civil service within Interior. During the war years he was with the Coast Guard. His Interior Department service since 1941 has covered tours with the Bureau of Indian Affairs, the National Park Service, the Geological Survey, and the Southwestern Power Administration, as well as his post in the Division of Budget which he held prior to this appointment.

A native of Altoona, Pa., he is a graduate in law from National University in Washington, D.C., also has studied at Johns Hopkins and American Universities. # # #

Lindseth Named Associate Chief Engineer



Emil V. Lindseth was named Associate Chief Engineer at the Bureau's Denver office, it was announced on August 20. Lindseth moves up from his former position of Assistant Chief Designing Engineer. He succeeds John Parmakian, who retired to establish a consulting engineer practice in Denver.

Assistant Chief Designing Engineer since 1958, Lindseth was before that the Assistant Regional Director of the Bureau's Region 7 office, beginning in 1949.

He began his career with Reclamation in Denver in 1934, serving as structural designing and hydraulic engineer. In 1944, he transferred from the Chief Engineer's office to hold various positions in the Region 7 office.

Lindseth recently was given a Special Act Award for important contributions to advances in the technology of ultra-high-voltage, direct-current transmission of electrical power.

He was graduated from Washington State College in 1927 where he was awarded a B.S. degree in electrical engineering. # # #

PRESIDENT KENNEDY DEDICATES WHISKEYTOWN DAM

PRESIDENT John F. Kennedy, speaking to an audience of thousands gathered at the unique and newly completed Whiskeytown Dam in the northern part of California's Central Valley project, dedicated the dam and reservoir on September 28.

After a speech voicing his pleasure at the construction of the Central Valley's conservation features as marked by the completion of Whiskeytown Dam, the President's plane flew him over other parts of the giant project as well as over Hoover Dam and Lake Mead en route to his next stop at Las Vegas, Nev. About 10,000 people at the Las Vegas Convention Center heard the President on this stop and also saw the world premiere of the Bureau's motion picture, "Clear Water on the Colorado."

The 278-foot-high Whiskeytown Dam is part of the Trinity River Division and creates Whiskeytown Reservoir which is capable of storing 250,000 acre-feet of water. Other units of the division are Trinity Dam and Reservoir, Lewiston Dam and Reservoir, Clear Creek Tunnel, Spring Creek Tunnel, and four powerplants.

The interesting fish conservation feature of Whiskeytown Dam involves two-level outlets for mixing two temperatures of water to provide a healthier environment for salmon and steelhead trout that frequent Clear Creek and Sacramento River.

The spillway for the dam consisting of a glory-hole entrance and a 21-foot-diameter reinforced concrete tunnel extending through the left abutement, will have a capacity of 28,780 cubic feet per second.

THE NAME—Whiskeytown received its colorful name from an incident of more than a century ago. In 1848, a barrel of whiskey, en route to a mining settlement, fell off a mule and into a creek serving the tiny community. The miners immediately named their community Whiskeytown, a name that prevailed until a post office was established there. The more prosaic Blair then replaced the former name. But in 1952, at the insistence of the townspeople, Blair was dropped and the town became Whiskeytown once more.

The dam, the town, and the reservoir now carry the distinctive name.

FLAMING GORGE POWER IS SIGNALED BY PRESIDENT KENNEDY—

By pressing a key in a ceremony at the airport at Salt Lake City, Utah, on September 27, President John F. Kennedy signaled the start of the first of three generators to be installed at Flaming Gorge Dam in a "drying out" and test run. The President's signal and also a voice interchange was accomplished by a direct-line connection between the airport and the dam, on the Green River in northern Utah. Construction Engineer J. R. Walton, located at the dam's powerhouse, received the President's signal and started spinning generator No. 1. # # #

People are awaiting President Kennedy's landing at Whiskeytown Dam. After leaving the helicopter, the President views Whiskeytown Lake. At left is California Congressman Harold T. Johnson. California's Governor Edmund G. Brown is between President Kennedy and Robert J. Pafford Jr. (right), Director of Region 2.

water report

by HOMER J. STOCKWEL
Water Supply Forecasting Uni
Soil Conservation Servic
Portland, Oreg

In direct contrast to water supply outlook during the midwinter months of 1962–63, water supplies have been relatively good for most irrigated areas west of the Continental Divide in 1963. Winter snowfall in the mountains lagged far below average until April 1. Precipitation which did occur in the West Coast States tended to fall as rain, causing immediate runoff rather than building up a mountain snowpack. Flood flows were experienced in early February. Up till the end of March, severe shortages were in prospect for most irrigated areas where carryover storage was limited or not available.

Storms during April were especially heavy in California, Nevada, and Utah, changing streamflow prospects from among the lowest flows of record to almost average. On some streams of California, above-average streamflow was in prospect.

Contributing to the favorable water supply situation this summer in the Columbia Basin, the Central Valley of California, and the Great Basin of Nevada and Utah, was the continuance of an above-normal rainfall and below-average temperature sequences during the summer months. This combination substantially reduced irrigation water demand.

East of the Continental Divide and on the Upper Colorado River Basin, water supply was much less plentiful. Streamflow was less than average in the upper Missouri and tributaries in Montana, and in the Yellowstone River in Montana and northern Wyoming. However, only limited late-season shortages occurred where storage was not adequate. Irrigation needs along the Platte River system of Wyoming and Colorado were met at the expense of severely depleting reservoir storage. Farther south, surface water supplies along the Arkansas and the Rio Grande were among the poorest of record.

Total flow of the Colorado River into Lake Mead, adjusted for storage in the new, large upstream reservoirs, was the lowest since 1934 and appears to be the second lowest flow of record Irrigation needs along the upper tributaries wer generally satisfied.

In the Lower Colorado River Basin, irrigatio water supply was average or better for the centra Arizona area.

The California Central Valley had the bes water year since 1958. The storm pattern whic began in April persisted through the summe months. Demands were reduced, and the statu

Melting Nevada snows provide a cool drink of water fo this snow surveyor.

of water supplies north of the Tehachapis is remarkably favorable at the start of a new water year.

Looking forward to 1964, storage and mountain soil moisture conditions are at least average west of the Continental Divide except for the Colorado River Basin. East of the divide, from Montana to New Mexico, irrigation storage is generally depleted. As of late September, falls rains in the area have not occurred, and soils are dry, and an above-average winter snowpack will be required in the Rocky Mountain area to bring storage up to normal operating levels and to provide a reasonably adequate water supply for next year.

An interesting trend has been noted where irrigation water supplies were short this year. Water users generally reduced irrigated acres in line with prospective supplies. Yields are reported good on a reduced number of acres planted. After an experience of dry years in the 1959–61 period, water users are avoiding extensive economic loss by planning acreages in line with available water supply.

This report for Reclamation Era, is prepared under the direction of R. A. Work, Head, Water Supply Forecasting Unit, Engineering Division, Soil Conservation Service, Post Office Box 2807, Portland, Oreg., and is based on information supplied by snow survey supervisors of the Soil Conservation Service* and the California Department of Water Resources.

The following paragraphs list more details of water conditions by states.

ARIZONA

Snowmelt season streamflow was below average. Carryover storage from a year ago, and heavy precipitation during August and September helped provide an above-average water supply. Carryover storage for 1964 is above average except for San Carlos.

Stockwater and range conditions are the best since 1958 except for a few isolated areas. Prospects for an average water supply for 1964 are good if winter snowfall is near average.

CALIFORNIA

The California Department of Water Resources, coordinating agency for the California Cooperative Snow Survey Program, reports that water conditions during the 1963 water year were generally good in all areas of California north of the Tehachapis. Southern California, however, again experienced a very dry year, receiving less than 20 percent of normal precipitation. The resulting overdraft of groundwater supplies caused a continuation of the general downward trend in water levels which was interrupted by the recoveries made in 1962. The lowest levels of record will occur in many of these basins this fall. These drought conditions were tempered by the above-normal runoff season in the Mono Lake and Owens River basins, which are important sources of municipal supplies in the south coastal area. Runoff in these basins was about 110 percent of normal, the greatest since 1958.

Streamflow in the other major hydrographic areas of the State was also the greatest since 1958, averaging over 140 percent of normal for coastal streams and about 130 percent of normal for Central Valley streams. More important, however, was the relatively high snowmelt runoff from the major Central Valley watersheds which provided excellent irrigation supplies and carryover storage throughout the area. In mid-March a record low snowpack over most of the Sierra and Cascade Basins foreboded serious deficiencies in water supplies. As late as April 1, the date when snowpack accumulation is usually at a maximum, the water content of the meager snowpack was only 35 percent of normal. Fortunately, the cool general storms of April resulted in additional accumulation of snowpack instead of the usual decrease. Consequently, on May 1, above-normal snowpack for that date had been attained and a good snowmelt runoff season was assured. Thus, the status of northern California water supplies at the beginning of a new water year is remarkably good, especially in comparison to the below-normal conditions that seemed a near statistical certainty a few months ago.

* The Soil Conservation Service coordinates snow surveys during the winter and spring months conducted by its staff and many cooperators, including the Bureau of Reclamation, Forest Service, Geological Survey, other Federal agencies various departments of the several States, irrigation districts, power companies, and others. The California Department of Water Resources, which coordinates snow surveys in that State, contributed information on California water supply as a part of this report. The Water Resources Service, British Columbia Department of Lands, Forests, and Water Resources has charge of snow surveys in that province.

COLORADO

Snowmelt season runoff during the 1963 irrigation season was among the lower years of record. Areas that had good carryover storage or a substantial supplemental supply, such as the South Platte, had a good water year. The usual high crop production was evident even with low streamflow and light precipitation from April through July.

Where direct flow was the principal source of water, serious shortages occurred. The Arkansas Valley was particularly dry. Considerable land was left idle because of the poor water prospects. The San Luis Valley produced fair crops from a limited surface water supply, but extensive use was made of ground water sources.

Reservoir storage is low throughout the State. Storage on the South Platte is now much lower than a year ago, both in Colorado-Big Thompson reservoirs and the smaller irrigation storage reservoirs throughout the basin.

IDAHO

Idaho had a consisitently good water supply during the 1963 season. The snowpack was unusually low until the spring season when heavy snowfall and rains increased volume flows significantly. The rains continued throughout the summer, eliminating several irrigations.

Reservoir carryover reflects the good water supply for the season, with average or better carryover expected for 1964. Early snow has already fallen on the higher mountains.

Forecasts made early in the winter of 1963 on the basis of the snowpack had to be revised upward each month as the season progressed. The trend continued, and rain at several southern Idaho stations was over 400 percent of normal during the summer months.

MONTANA

The 1963 water supply was generally adequate through mid-July, but late season shortages were common on streams with limited reservoir storage. Streamflow was near average on the extreme headwaters of the Missouri and Yellowstone Rivers, but only one-half to two-thirds of average on the northern tributaries to the Missouri. Snowmelt streamflow in Columbia River tributaries was slightly better than anticipated—75 to 90 percent of average.

Storage in irrigation reservoirs decreased rapidly during the heavy demand period of July and August. Carryover storage for 1964 will be below average for most reservoirs in the State.

The outlook for 1964 can be stated as only fair at the present time. However, an average winter snowpack could provide an adequate water supply for next season.

NEVADA

Irrigation water supplies in Nevada for 1963 were good, a complete reversal of the outlook up to the first of April which indicated a streamflow year comparable to 1961. Water outlook appeared very poor except for carryover storage.

Rainfall from April to June, an important factor in streamflow, was in excess of 200 percent of average except for the extreme southern section of the State. This rainfall not only increased streamflow but reduced irrigation needs. The below-normal temperatures resulted in an optimum yield of water from the snowpack and sustained late-summer streamflow.

Mountain soil moisture has improved as a result of recent storms but only the surface few inches are wet as of late September. Reservoir storage is near average in all principal reservoirs including Lake Tahoe.

NEW MEXICO

One of the lowest water years of record occurred this year on the Rio Grande through New Mexico. Crop production was down in all areas except those where extensive pumping is practiced.

The Carlsbad and Tucumcari projects relied heavily on carryover storage, which at the end of the water year is substantially below average and much less than for the past 2 years.

OREGON

Most irrigated lands in Oregon have had adequate water supplies. Crop production has been good. This has occurred, even if a remarkably mild winter indicated poor water conditions all the way till the end of March. Then the rains came. Rainfall was considerably above average in April, May, and June throughout most of the State, reversing the water supply outlook from near drought to generally adequate. Some lands in Umatilla County were out of water near the

end of the season, and other small areas had similar shortages.

Holdover water in irrigation reservoirs will be fairly limited but is quite encouraging in Malheur, Crook, Deschutes, Jefferson, Jackson, Klamath, and Lake Counties and on Willamette tributaries.

Moisture in watershed soils is about normal. Early winter rainfall usually is adequate to prime mountain soils under the coming snowpack.

UTAH

Water supplies have been generally adequate this summer in northern sections of Utah. In southern sections irrigation water was very short, but the effect was somewhat offset by good rains during August and September.

Here, as in central areas, the economic effect of short water supplies was softened by adjustments in acreages and ordinary cropping patterns. Acreages of crops needing late summer water were reduced to that for which adequate water would be available, resulting in the lowest acreage of potatoes in this century and the third lowest acreage of sugarbeets since 1906.

Carryover storage, while below average in northern reservoirs, is much better than on the Sevier and Beaver Rivers where there will be very little holdover water for 1964.

WASHINGTON

The water supply situation has been a series of contradictions this year. There was very little snow in the mountains on April 1; however, the combination of fall rain, winter runoff, and high storage contributed to a water supply outlook that was not as poor as snowpack alone would have indicated.

After April 1, heavy rains came at lower elevations, and snow fell in the higher mountains.

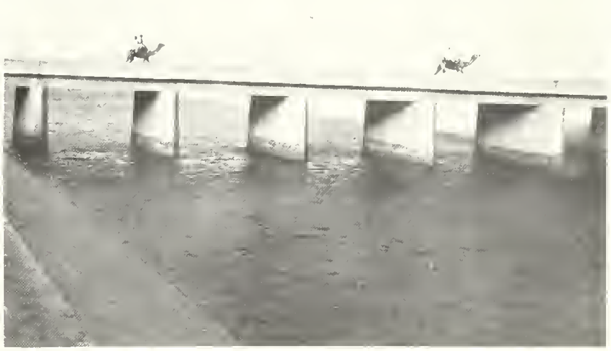
RAJASTHAN *Continued from page 92*

Progress is slow, as only 16 miles of canal are constructed per year. But by their way of measuring time evidenced by ancient forts, roads, and temples, they are willing to work and wait. Eventually, great quantities of food and fiber will come from this expanse of land and homes for 2 million people will be established.

Even though hand labor receives only about rupees 3 per day (about 63 cents), cost of the main canal is running close to $1 million per mile.

Along one stretch, modern earthmoving machines were making a large cut through a sand dune and constructing a fill beyond it. These machines, moving into the cloud of dust and emerging with their loads, seemed too few and too old for the gargantuan task. They were working long past the retirement age, most of them having done time on the Burma Road during World War II and had also been used at Bhakra to build that great dam. Tankers carrying diesel fuel and oil are towed in by Caterpillar. The dusty conditions are endured even when making motor repairs.

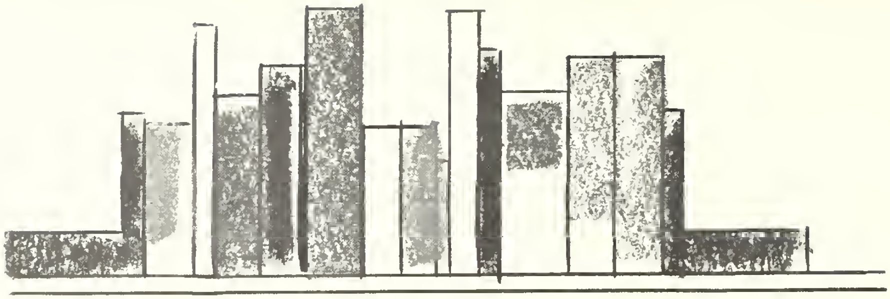
When it was made known that the centerline of the big canal would pass directly through a small desert village, the head man shouted for joy. During the 10-month-long dry season each year, people in his village carry water in goatskins on the backs of their burros, over some 22 miles of desert trails.



A contrast of centuries of time is exemplified by this view of camel travelers crossing a modern Rajasthan bridge.

Other members of the Beas Investigations team were Herbert Riesbol, C. O. Crane, and A. Walter Schmidt. Their primary purpose while in India was to make an investigation of the Beas Dam project and its various features for the Agency for International Development. The team returned to Denver in early June where the final report was written.

As for the Rajasthan construction in India, the investigation was an impressive one. And some day, India's men and women will see the completion of the project which will return a river to the Great Desert of their country. # # #



BOOKSHELF for water users

BOOK ON CANAL LININGS IS PRINTED. *Linings for Irrigation Canals*, an illustrated book of 149 pages, is now off the press. The publication contains instructions, standards, and procedures developed by the Bureau of Reclamation for use in the lining of irrigation canals, and includes a progress report on the lower cost canal lining program. This contains nine chapters, a bibliography, and an index.

This canal-lining publication is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402, Price: $1.25 (paperback); and the Bureau of Reclamation, Denver Federal Center, Denver 25, Colo., Attention: 841, Price $1.25 (paperback), and $2.25 (buckram).

REPORT ON EUROPEAN DAMS COMPLETED. A three-volume report entitled "European Practices in Design and Construction of Concrete Dams" has been completed by Bureau engineers Merlin D. Copen, George C. Rouse, and George B. Wallace, all of Denver, Colo. The technical and illustrated publication includes the team's report from 6 countries and the results of investigations of 43 dams in various stages of completion, 25 power stations, 13 laboratories, 6 manufacturing plants, and interviews with more than 100 engineers.

Countries reported upon by the three-man team include Portugal, Italy, Austria, Switzerland, France, and England. Volume 1 includes an introduction, "Design of Concrete Dams, and Powerplants." Volume 2 includes "Construction Plants and Practices," "Mix Design and Properties of Concrete," and "Materials and Construction Laboratories." Volume 3 includes "Foundation Testing," "Structural Model Testing," and "Structural Behavior of Dams."

Copies of these volumes are available from the Denver address above.

# # #

Streamflow was relatively good during the late spring and early summer. The situation was reversed in late season. Precipitation in the mountains has been low, and streamflow has declined. Reservoirs have been drawn down and are going into the winter with a below-average carryover.

The winter period will start with dry mountain soils, a low baseflow in the rivers, and low storage in the reservoirs. Usually, fall rains prime mountain soils. If another winter snowpack like last year occurs, a serious water shortage could develop.

WYOMING

Water supplies were adequate throughout the State. On the North Platte, irrigation demands required a substantial depletion of storage in the larger reservoirs. Inflow to Seminoe Reservoir was in the range of two-thirds to three-quarters of average. Summer flow of the Bighorn and its tributaries was near average and provided for water needs. Green River flow was below average but substantially above that of other Colorado River tributaries.

The summer months have been dry. A general storm with small amounts of rainfall occurred in late September, but soils in both mountain and valley areas are short on moisture. The outlook for next year is fair to good if the winter snowpack is near average. # # #

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1961–63

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MAJOR RECENT CONTRACT AWARDS

Specification No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-5933	Colorado River Storage, Colorado-Wyoming	July 2	Construction of the 157-mile Hayden-Archer (Cheyenne) 230-kv transmission line.	Paul Hardeman, Inc., Stanton, Calif.	$5,622,408
DC-5939	Missouri River Basin, South Dakota-Nebraska	July 2	Construction of the 301-mile Oahe-New Underwood-Stegall 230-kv transmission line.	Donovan Construction Co., St. Paul, Minn.	7,838,461
DC-5953	Colorado River Storage, Arizona	July 10	Construction of 8.2 miles of experimental section of Glen Canyon-Shiprock 230-kv transmission line.	Construction Helicopters, Inc., Grand Junction, Colo.	180,794
DC-5955	Norman, Okla	Aug. 9	Construction of reservoir and relift pumping plants and chlorination station.	Lee-Emmert, a corporation, Richardson, Tex.	1,219,523
DC-5957	Missouri River Basin, Nebraska	July 23	Construction of 17 miles of concrete-lined Ainsworth canal, Sta. 1914+50 to 2832+77.79 sections 4 and 5.	Bushman Construction Co., St. Joseph, Mo.	2,271,084
DS-5958	Kendrick, Wyo	July 11	Constructing turbine model, conducting tests, and furnishing new turbine parts for Seminoe powerplant. (Negotiated contract.)	Baldwin-Lima-Hamilton Corp., Industrial Equipment Division, Philadelphia, Pa.	421,750
DS-5963	Parker-Davis, Arizona	July 22	Area load and frequency control equipment for control of Parker-Davis transmission system from Phoenix dispatcher's office.	Leeds & Northbrup Co., Philadelphia, Pa.	172,487
DC-5965	Lower Rio Grande Rehabilitation, Texas	July 19	Clearing, and constructiou of earthwork, 5.7 miles concrete lining, and structures for rehabilitation of 10.3 lateral system.	E. and M. Bohuskey Construction Co., Harlingen, Tex.	312,433
DS-5967	Central Valley and Colorado River Storage, California-Colorado.	Aug. 1	Ten 156-inch butterfly valves for San Luis dam outlet works and Blue Mesa powerplant.	Mitsubishi International Corp., New York, N.Y.	891,950
DC-5970	Colorado River Storage, Colorado.	July 23	Construction of an administration and dispatching building at Montrose, Colo.	H. W. Houston Construction Co., Pueblo, Colo.	973,705
DC-5973	Missouri River Basin, South Dakota	July 18	Construction of James diversion dam	Sornson Construction Co., Fargo, N. Dak.	281,513
DC-5977	Central Valley, Calif.	Aug. 16	Construetion of 21.7 miles of concrete-lied San Luis canal, Sta. 910+10.09 AH to 2053+15.	Morrison-Knudsen Co., Inc., and Utah Construction & Mining Co., South Gate, Calif.	11,946,5
DC-5979	Weber Basin, Utah	Aug. 20	Construction of 1.9 miles of pipeline for Stone Creek stream inlet.	R. W. Coleman Co., Brigham City, Utah.	203,876
DS-5981	Seedskadee, Wyo.	Sept. 17	Furnishing and installing one 11,111-kva generator for Fontenelle powerplant.	Mitsui & Co., Ltd., San Francisco, Calif.	263,300
DC-5982	Central Valley, Calif.	Aug. 30	Construction of Mile 18 pumping plant utiizing monolithic-concrete pipe for the discharge lines, Schedules 1 and 2.	Stolte, Inc., M. M. Sundt Construction Co., and Santa Fe Engineers, Inc., Oakland, Calif.	
DC-5986	Missouri River Basiu, Nebraska	Sept. 20	Construction of 26 miles of Farwell South and Farwell Upper South canals; and 62 miles of Farwell South laterals S-14.8 to S-30.8 and Farwell Upper South laterals U.S.-0.9 to U.S.-7.8, and sublaterals.	Bushman Construction Co., St. Joseph, Mo.	1,714,382
DC-5987	Gila, Ariz.	Sept. 10	Constructiou of 4.2 miles of concrete-lined South Gila canal aud 10.7 miles of cast-in-place concrete pipeline laterals for South Gila Valley Unit distribution system, schedule III, Schedules 1 and 2.	M. R. Latimer Denver, Colo.	1,114,139
DC-5991	Missouri River Basin, N. Dak.	Sept. 17	Construction of stage 07 additions to Fargo substation.	Power Engineering Co., Inc., Sioux City, Iowa.	257,800
DC-6002	Missouri River Basin, Mont.	Sept. 20	Construction of roadway and structures and laying track for relocation of 6.2 miles of Chicago, Burlington & Qunicy RR. for Yellowtail dam.	Brasel & Sims Construetion Co., Lander, Wyo.	327,787
100C-630	Vale, Oreg.	July 23	Construction of lateral 197-13, Sta. 70+00 to end	John M. Keltch, Pasco, Wash.	235,557
100C-633	Yakima, Wash.	Aug. 15	Construction of precast-concrete siphons for siphon and flume replacements for Maiu caual, Sunnyside Irrigation District.	Lewis Hopkins Co., Pasco, Wash.	151,336
200C-530	Central Valley, Calif.	July 22	Construetion of a survey and inspection building, geology building, field office and field laboratory buildings, and an automotive maintenance shop for San Luis dam.	C. W. Jessen Construction Co., Fresno, Calif.	276,941
200C-531	do	Aug. 15	Removal of debris from Spring Creek powerplant tailrace channel.	J. F. Shea Co., Inc., Redding, Calif.	168,000
200C-534	do	Sept. 16	Coustructing Trinity powerplant access road and paving area at Lewiston powerplant; bituminous surfacing and seal coating for Trinity River fish hatchery area, Whiskeytown dam access road, and Whiskeytown dam and Brandy Creek roads.	J. P. Breen, Sr., Saeramento, Calif.	127,854
300C-185	Delivery of Water to Mexico, Arizona.	July 12	Drilling 25 drainage wells for Wellton-Mohawk area. (Negotiated contract.)	John C. Maxwell, dba Wisconsin Pump Service, Stevens Point, Wis.	276,310
300C-188	do	July 19	Construction of 20 miles of precast-concrete pipelines for drainage well collection system for Wellton-Mohawk area, Schedule 2.	American Concrete Pipe Co., Phoenix, Ariz.	828,936
300C-190	do	Aug. 16	Constructing wasteway structures with overflow spillways and modifying existing siphons for Wellton-Mohawk area.	Karl A. Dennis, dba Dennis Construction Co., Yuma, Ariz.	129,959
602C-40	Missouri River Basln, S. Dak.	Aug. 2	Construction of Faith substation	Lindstrom Construction Co., Grand Forks, N. Dak.	115,000
300C-196	Delivery of water to Mexico, Ariz.	Sept. 23	Furnishing and installing 121 miles of drain tile for farm drain tile and collection system, Wellton-Mohawk area, Blocks 1 through 12. (Negotiated Contract.)	Kimbo Co., Box 186, Coachella, Calif.	1,682,785

U.S. GOVERNMENT PRINTING OFFICE: 1963 O—705-910

Major Construction and Materials for Which Bids Will Be Requested through November 1963*

Project	Description of work or material
anadia River, Tex	Constructing 4 indoor-type pumping plants each having a 43-ft-wide by 151-ft-long reinforced-concrete substructure, with 5 motor-driven pumping units having a total capacity of 683.4 cfs. The plants will have structural-steel superstructures supporting either 5- or 7-5-ton cranes and will be enclosed with insulated metal siding. Main Aqueduct, between Sanford and Amarillo, Tex.
entral Valley, Calif	Constructing the Los Banos Creek Detention Dam, a 2,100,000-cu-yd earthfill structure about 154 ft high and 1,370 ft long, with a chute-type spillway in the left abutment and an outlet works consisting of an intake structure, a concrete-lined tunnel, control structure, and stilling basin. Work will also include earthwork and surfacing for about 2 miles of access road and constructing a service road to the control structure. On Los Banos Creek, 7 miles southwest of Los Banos.
Do	Constructing the 6-unit Forebay Pumping-Generating Plant 194 by 70 by 108 ft high; installing Government-furnished pump turbines; and furnishing and installing electrical equipment. Work will also consist of closing an earth dam which is being constructed under another contract and constructing spillway and discharge structures. About 12 miles west of Los Banos.
Do	Furnishing and installing and testing 8 vertical-shaft, multiple-rated, 2-speed, 13,800-volt motor generators rated 50,000 kva at 150 rpm, 37,500 kva at 120 rpm, 57,500 hp at 150 rpm, and 30,000 hp at 120 rpm. San Luis Pumping-Generating Plant.
lorado River Front Work and Levee System, California.	Constructing Senator Wash Dam and dikes with a total volume of about 1,700,000 cu yd. The dam will be about 85 ft high and 2,180 ft long, and the largest of 3 dikes will be about 77 ft high and 3,810 ft long, the spillway will be a chute-type structure, and the outlet works a conduit with gate chamber and access shaft. Work will also include constructing a pumping-generating plant, 52 ft 6 in. wide and 143 ft long, to house 6 vertical-shaft pump-turbines directly connected to motor generators. 22 miles northeast of Yuma, Ariz., and about 2 miles upstream from Imperial Dam.
RSP, Colorado	Constructing about 84 miles of the Curecanti-Poncha 230-kv, single-circuit transmission line will consist of clearing right-of-way; constructing concrete footings; furnishing and erecting steel towers; furnishing and stringing three 1,272 MCM, ACSR conductors and two ½-in., steel strand, overhead ground wires; and furnishing and installing fence gates. Along alinement extending from near Montrose, to near Poncha Springs, Colo.
Do	2 vertical-shaft, Francis-type, hydraulic turbines rated 83,000 hp at 344 ft net head for the Morrow Point Powerplant.
CRSP, Wyo. (Region 7)	Constructing the Archer Substation will consist of constructing a concrete masonry service building; constructing concrete foundations; furnishing and erecting steel structures; furnishing and installing 3 single-phase, 100-mva, 230/115-kv transformers, two 230-kv, five 115-kv, and two 14.4-kv circuit breakers, 6 single-phase, 5-mva shunt reactors, and associated electrical equipment: and grading and fencing the area.
Emery County, Utah	Constructing about 11 miles of Cottonwood Creek-Huntington Canal with bottom width varying from 12 to 8 ft, about 4 miles of which is to be lined with buried asphalt membrane lining. Near Castle Dale.
Gila, Ariz	Constructing about 2 miles of 24-in.-diameter precast-concrete pressure pipelines; about 1 mile of 24- to 30-in. precast-concrete pipelines of either reinforced pressure pipe, unreinforced pressure pipe or reinforced culvert pipe; about 5 miles of 30- to 54-in.-diameter pipelines of either cast-in-place, reinforced pressure pipe or reinforced culvert pipe; and five 12-cfs pumping plants. Near Yuma.
MRBP, Iowa and Missouri.	Furnishing and constructing about 59 miles of Creston-Maryville 161-kv, wood-pole transmission line; and furnishing and stringing three 556.5 MCM, 24/7, ACSR conductors and two ⅜-in., high-strength, steel strand, overhead ground wires. Along alinement extending from near Creston, Iowa, to near Maryville, Mo.
MRBP, S. Dak. and Iowa.	Constructing about 75 miles of 230-kv, single-circuit transmission line (Sioux Falls-Sioux City), will consist of clearing right-of-way; constructing concrete footings; furnishing and erecting steel towers; furnishing and stringing three 795 MCM, ACSR conductors and two ½-in., steel strand, overhead ground wires; and furnishing and installing fence gates.
MRBP, Montana	Furnishing, installing, and testing four 65,789-kva, 0.95-pf, 13,800-volt, 225-rpm, 60-cycle, vertical-shaft, hydraulic-turbine-driven, alternating-current generators for Yellowtail Powerplant.
MRBP, South Dakota	Furnishing and stringing six 1,272 MCM, 45/7, ACSR conductors, and two ½-in., high-strength, steel strand, overhead ground wires for 146 miles of Fort Thompson-Sioux Falls 230-kv, double-circuit, steel tower transmission line.
MRBP, Wyoming	Furnishing and constructing about 33 miles of the Glendo-Lusk Section of the Glendo-Lusk-Osage 115-kv, wood-pole transmission line; and furnishing and stringing three 477 MCM, ACSR conductors and two ⅜-in., steel strand, overhead ground wires.

*Subject to change

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U.S. Department of the Interior
Bureau of Reclamation

February 1964

Reclamation ERA

U.S. Reclamation Commissioner Observes Irrigation in U.S.S.R.

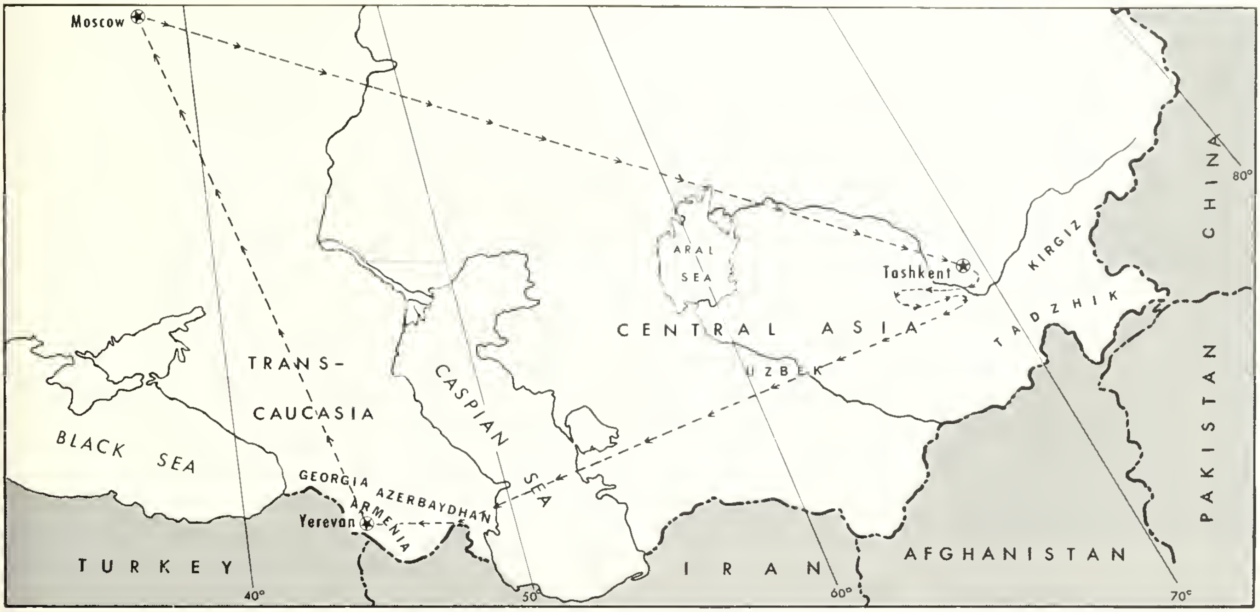
Reclamation ERA

FEBRUARY 1964
Volume 50, No. 1

COVER PHOTO—Snow scene in the Wasatch Mountains near Alta, Utah

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. Use of funds for printing this publication has been approved by the Director of the Bureau of the Budget, January 31, 1961.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Price 15 cents (single copy). Subscription price: Eight issues (2 years) for $1.00 ($1.50 for foreign mailing).



THE WATER RUSH IN RUSSIA

by Reclamation Commissioner FLOYD E. DOMINY

SOVIET leaders make no secret of their plans to overtake the United States, indeed as Khrushchev has said "to bury you," in the utilization of heir natural resources as in all other production.

In support of their ambitions, U.S.S.R. irrigaion officials aim to develop 2.5 million acres of iew irrigation lands each year for the next 20 ears. This goal seemed incredible to us as speialists of reclamation in the United States, until ve had the opportunity to asses the actual deelopment and potential of Russia's land and vater resources.

On the 3-week cultural exchange tour made last September, I headed a group of top U.S. rrigation engineers and leaders who inspected xisting and potential irrigation developments in he U.S.S.R. Members of the U.S. delegation rom the Department of the Interior were Deputy Assistant Secretary of the Interior Robert V. Nelson and Bureau of Reclamation members, Gilbert G. Stam, Chief of the Division of Irrigaon and Land Use, Washington, D.C.; Hollis Sanord, Chief of the Division of Irrigation Operations; and Frank E. Rippon, Chief of the Canals Branch, both of the Office of Chief Engineer, Denver, Colo.

Other U.S. delegates were Ned Greenwood of the Soil Conservation Service; M. C. Bryant, rancher and businessman from San Angelo, Tex.; Floyd E. Bonge, vice president of the Eastern Municipal District, Hemet, Calif.; Dr. J. B. Fuller, member of the Federal Farm Credit Board and longtime chairman of the board of commissioners of the Goshen Irrigation District, North Platte project, Nebr.; and LaSelle E. Coles, past president of the National Reclamation Association, Prineville, Oreg.

Local Soviet officials repeatedly made reference to the importance of irrigation in meeting the food and fiber needs not only of the U.S.S.R. but also of the underdeveloped nations of the world. It is plain that these leaders are looking to the dependability of irrigation in their homeland to strengthen their bid for world supremacy. Consequently, Soviet officials are moving rapidly, though somewhat awkwardly, to develop their

U.S. irrigation specialists queried Soviet officials about their wide use of concrete flumes as shown here rather than going to buried concrete pipe.

country's vast potential in water and land resources.

Visited Two Important Areas

Escorting the American delegation wherever we requested, cordial Soviet hosts arranged for the *Americanskys*, as we are called in that country, to become acquainted with two important irrigation areas, Central Asia and Transcaucasia.

In Centural Asia, the Republic of Uzbek, which has a most picturesque land and culture, is one of the greatest producers and is a major contributor to the Soviet Union's Central Asian bread basket. A primitive Uzbek people was captured by the Russian czars in 1859. Even with modern technology utilizing their rich native soil, these primarily Asiatic people called Uzbekians still live a relatively primitive and genuinely friendly existence. The adjacent Republics of Tadzhik and Kirgiz are similarly impressive.

People in the Republics of Azerbaidzhan, Georgia, and Armenia in the Transcaucasian area live in a more advanced technology and European influence in contrast to those of the Central Asian Republics.

Located along the 40th parallel, which in the United States is the border dividing Nebraska and Kansas and cuts through the northern parts of Colorado, Utah, Nevada, and California, these high water-yielding areas include millions of acres of fertile land suitable for irrigation.

Many thousands of acres of the primary crop of cotton can be seen from roadsides. A few single-row cottonpicking machines were observed in equipment yards, but nearly all of the irrigated cottonfields are harvested by the armies of handpickers. In contrast, nearly all of the irrigated cotton in the United States is picked mechanically.

Alfalfa and corn production is spotty, but are used to some extent in rotation with cotton. Grapes are grown in great variety and quantity. Other important specialty crops include melons, figs, peaches, pears, apples, and nuts. Production of silk is important in some parts.

Sheep Grazing Heavy

Central Asia grazes millions of sheep, primarily the fat-tailed variety, and comparatively few cattle. In Transcaucasia, the relative importance of cattle was greater. Most cattle are the dairy or dual purpose type, with quality only fair. Development plans call for irrigation of several hundred thousand acres of mountain valley grazing land in Transcaucasia, which will improve the distribution of stockwater and increase production of milk, meat, and wool.

An infestation of noxious weeds including Canada thistle prevails in overabundance and remedial action is not evident.

Each Republic has its own well-financed design institute and hydraulics laboratory to exercise major influence over the formulation of new project plans and construction. Operations at the institutes include work in irrigation, drainage, hydraulics, soils, economics, soil and water relationships, hydraulic structures, soil mechanics, sprinkler irrigation, and machine testing. The Georgian S.S.R. hydraulics laboratory alone has an annual budget of $750,000.

Seepage from canals is a severe problem in some areas and local officials have not yet determined upon the best method of treatment. In one case the loss was estimated to be 17 percent in a 36-mile reach, a loss similar to that of many unlined canals in western United States.

Many miles of precast concrete flumes are being installed to distribute irrigation water to irrigable lands.

Because of expansion and contraction, the joints in concrete flumes open up and leak to some extent. This results in settlement of the flume supports, misalinement, and other maintenance problems.

This small canal brings water to the vertical intake to a siphon in the right foreground.

A diversion dam and sediment basins in Georgia SSR.

A new type of mastic for sealing the flume joints is being developed and used in some lines. The new mastic is presumably an adhesive type of plastic material with considerable elasticity.

Some good-quality asbestos cement pipe is manufactured in the Soviet Union and is being used to a limited extent in the irrigation systems. However, virtually no concrete pipe is manufactured or used for this purpose.

In the Hungry Steppe generally the lands are afflicted by severe salt problems. The reclamation process includes construction of main drains, lateral drains, and numerous temporary open drains to permit rapid leaching of the soils. Land containing 8 percent salt must be reduced to 2 percent before crops are planted. Some of these lands are planted to rice for 3 to 4 years. After the salt problem is sufficiently corrected, cotton is planted.

After initial reclamation, the temporary drains are eliminated and many of the permanent drainage laterals are lined in tile. A machine developed in the U.S.S.R. is reported capable of laying drainage tile up to 10½-foot depths.

A large plant operation serving the Hungary Steppe development makes precast reinforced-concrete flume sections in four sizes with depths of 16, 24, 32, and 40 inches.

In Azerbaidzhan, which currently irrigates 3 million acres of land, the 60-foot-high Pirsagat Dam is being constructed of an expansive clay to provide supplemental irrigation water to an area principally devoted to feed crops and livestock. Their method of dam construction is not being used in the United States. When taken from the pits, the clay is 16–18 percent moisture by weight. After the clay is placed on the dam by truck and spread by tractor-dozer, water is added to raise the moisture content to 27 percent. No mechanical compaction is used except that which is incidental to movement of trucks and tractors over the surface as the layers are applied.

A large amount of irrigable land is irrigated by sprinkler systems. The sprinkler heads are of different design, but similar in principle to those in the United States.

Leaders of the exchange teams. E. I. Ozerskiy, left, led the Russian delegation, and Commissioner Dominy, the U.S.A. group.

A Grand Fergana canal high velocity check and drop structure in operation.

The Republic of Armenia has some irrigation works in and near its capital city of Yerevan which are reported to be 2,000 years old. Extending from Lake Sevan to Yerevan is the costly Sevan-Razdan Power and Irrigation System now irrigating 32,000 acres of land. When completed it will irrigate 74,000 acres. The system includes 178 flumes (78 are finished and in operation), 70 steel siphons, and 13 bridges. The route of the canal contains eight power sites, six of which have been developed. All are operated from a central control panel in Yerevan and are interconnected with the Transcaucasian Power System. Two of these plants are constructed underground.

A portion of the shoreline of Lake Sevan is equipped experimentally with automatic devices for applying fatty alcohols (principally hexadecanol) to the lake surface to reduce surface evaporation.

Some Comparisons

Similar research is being conducted in the United States by or in cooperation with the Bureau of Reclamation, the chief difference being that we have concentrated on the use of a powdered form of compound, while the U.S.S.R. is using a liquid. Laboratory officials supplied the tour group with a sample of the Soviet's liquid compound. They reported experiments to date reveal that evaporation from Lake Sevan can be reduced 20 to 25 percent.

To reclamationists from the United States who inspected the water resource facilities and developments in the Soviet Union, it is evident that the differences in the programs of the two countries are like the differences in the philosophies of the two. America's development is dependent primarily upon individual initiative and free enterprise, and the Soviet's upon decisions and orders from the Committee and the followers of Lenin.

In spite of gigantic efforts to increase production, improve housing, and generally raise standards of living, years will be required for Russia to develop, manufacture, and build the plants, products, and structures necessary to equal the present-day accomplishments of the United States.

Although it is not known what proportion of the national budget is used for development of her rich natural resources compared to the share devoted to the buildup of military might and exploration of space, it is evident that the Soviets neither waste time nor withhold rubles from their reclamation effort.

Whatever the outcome of the Soviet move, it will behoove us to spare no effort, under our own system of private enterprise and cooperation, to maintain and foster a positive resource development program. It is a keystone in our national economy. # # #

Drinking water for stock is raised from 150-foot depth by means of a long 4-inch-wide belt weighted at the bottom end and pulled by the 3½ horsepower motor shown here.

A Potential Food Deficit Area* . . .

FROM OUT OF THE WEST

by Loren C. Holt,
Economist, Region 2

HORACE GREELEY'S admonition of the 1860's to "Go West, young man," even now carries its popular appeal. The West of today is the fastest growing region in the United States. To be sure, westward expansion was slow initially, requiring almost half of the 350-year period elapsed since settlement of the east coast to cross the Appalachian Mountains. However, from the time the mountains were conquered, the westward movement has gained ever-increasing momentum.

In the past 100 years, the West has passed from a sparsely settled frontier to a well-developed area containing, according to the 1960 census, the Nation's second most populous State, California, and largest urbanized area, the Los Angeles metropolitan complex. The population center has moved steadily westward from Chesapeake Bay near Baltimore in 1790, to southern Illinois, some 60 miles east of St. Louis by 1960.

In 50 years, the population of the Western States has quadrupled and is expected to more than triple the 1960 population of 27 million in the next 50 years.

Cropland in the West

Western expansion was well suited to farming for the first half of the distance from the Atlantic to the Pacific coast. But expansion from about the 100th meridian westward was over semiarid and desert lands interspersed with mountains. Figure 2 (on the following page) shows the scarcity of cropland west of a line roughly parallel to the eastern boundary of Colorado. This is in sharp contrast to the abundance of cropland east of this line. Though much of the cropland in the Western States is inherently fertile, most of it must be irrigated in order to secure profitable production. Irrigation has, of necessity, gone hand in hand with settlement and development of these States. As irrigation increased, it provided the base which supported the economy.

Irrigated land has also been important in the development of the tier of six semiarid Plains States lying east of Colorado. The relatively abundant croplands of these States are only modest producers without water to supplement the often inadequate rainfall. Irrigation serves to increase the productivity of these croplands, and provides the needed flexibility which enables shifts from the growing of wheat to the production of other crops which are in greater demand. The shift from dry-farming to irrigated farming in this area, a part of which was the Dust Bowl of the 1930's, is expected also to lessen the probability

Photo above—Four-year-old Dennis Nelson of Pleasant Grove, Utah, is proud of his selection of a huge pumpkin.

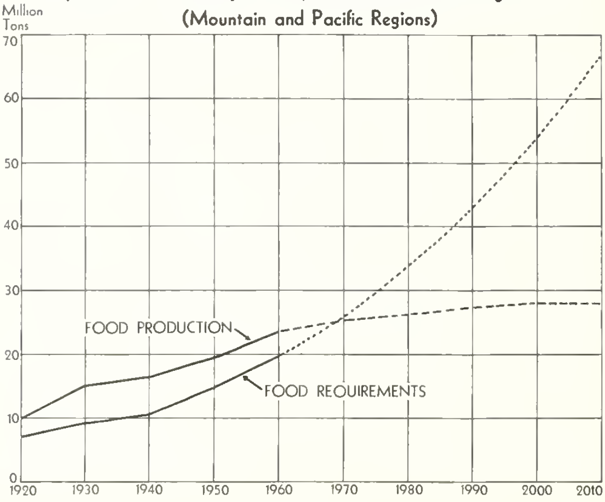


FIGURE 1

of a recurrence of the "black blizzards." However, the situation in the Plains States is somewhat different from that in the States farther west where irrigation is not merely helpful, but is in most cases an absolute must.

The Expanding Population

Although the population of the Nation as whole has increased rather rapidly in recent years 18.5 percent from 1950 to 1960, the increase in th Western States has been even faster. During th decade, the rate of growth in most of the Moun tain and Pacific States has exceeded the nationa average, as is strikingly portrayed by figures and 4 on the following page. Six of these State were among the 10 fastest growing States in th Nation.

Population of the West *tripled* in the past 4 years, while the population of the remainder o the United States increased by 57 percent and th United States total, including the Western State increased 69 percent. Present indications poin toward a continuation of this pattern of growth Figure 3 shows population projections for th United States as a whole and for the 11 Wester States.

Figure 5, by the use of index numbers, place the U.S. totals and the Western States on a com parable basis (1920 equals 100 in each case) so tha rates of growth may be compared.

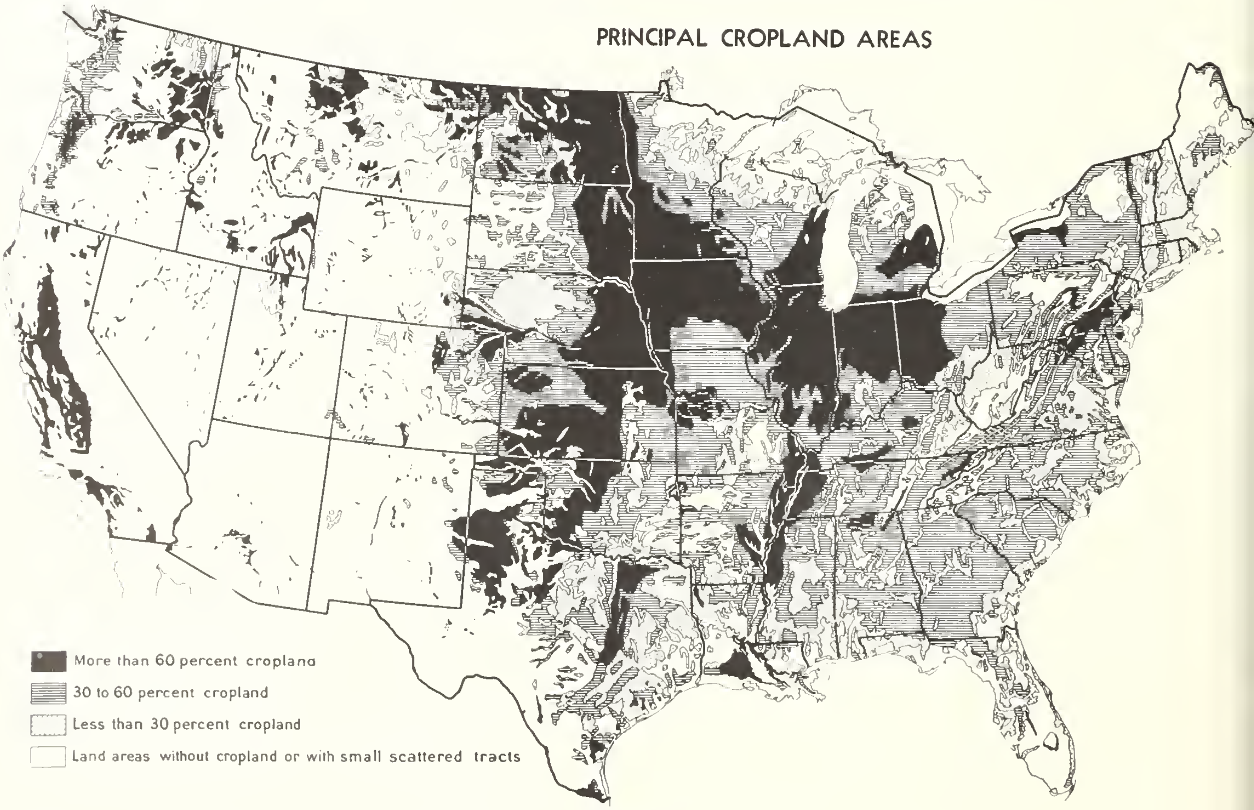


FIGURE 2

Footnotes at end of article.

Food Production

Owing largely to private and public irrigation development, food production in the West has kept pace with the expanding population, notwithstanding the relative scarcity of cropland. In addition, irrigation development has offset to a considerable degree the sizable acreages of valuable cropland that have been lost to nonagricultural uses. In California alone, nearly 1 million acres of land suitable for cultivation have been converted to nonagricultural uses since 1942. Roads, freeways, airports, subdivisions, and industrial enterprises now occupy these lands—one-third larger in size than the State of Rhode Island.

Population—United States and West Relative Increase

Year	Actual count [1]		Index numbers 1920=100	
	United States	11 Western States	United States	West
1910	92, 228, 496	6, 825, 821		
1920	106, 021, 537	8, 902, 972	100. 0	100. 0
1930	123, 202, 624	11, 896, 222	116. 2	133. 6
1940	132, 164, 569	13, 883, 265	124. 7	155. 9
1950	151, 325, 798	19, 561, 525	142. 7	219. 7
1960	179, 323, 175	27, 194, 165	169. 1	305. 4
1970	214, 098, 000	35, 257, 000	201. 9	396. 0
1980	260, 578, 000	46, 507, 000	245. 8	522. 4
1990	316, 560, 000	58, 800, 000	298. 6	660. 5
2000	383, 072, 000	73, 947, 000	361. 3	830. 6
2010	458, 700, 000	91, 700, 000	432. 6	1, 030. 0

FIGURE 3

From the standpoint of food production capacity, it is unfortunate that the lands that are best suited to cultivation are also the most desirable to develop for nonfarm uses. Such lands require less preparation, such as leveling, and are least expensive to build over; typically, these lands also boasted a ready water supply, now conveniently preempted by urban demands. The town that grows into a city is usually surrounded by rich farmlands. It is the presence of this agricultural wealth that causes the town to grow. Urban growth, much like a fungus that gradually strangles its host, consumes the surrouding farmlands to allow the city to spread. Much of this expansion is haphazard and uncontrolled. Far-sighted communities are beginning to take positive steps to control and restrain the ill-considered

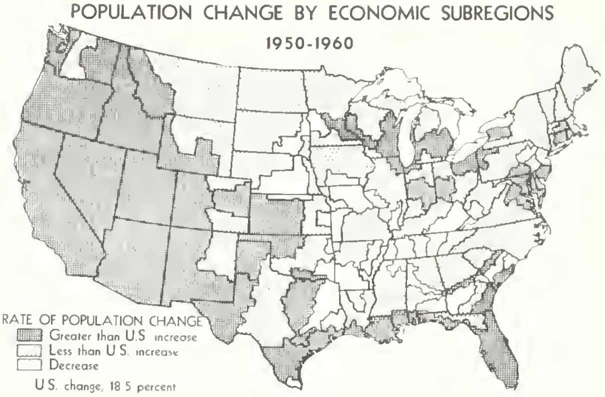


FIGURE 4

spreading of concrete and asphalt over choice farmlands. Planners are moving toward rural zoning as a tool to direct more of the building onto the poorer lands and to save the more fertile lands for agricultural production. For the sake of future generations, it is to be hoped that "green-belt" zoning does not prove to be "to little and too late."

Should the development of additional croplands cease, western agricultural production would soon fall behind the demands of the growing population. In spite of all that increasing yields (dependent in part on the more effective use of water) can do to offset diminishing croplands, the West would cease to be self-sufficient by about 1970. (See fig. 1.) From that point onward, in-shipments of food from areas farther east would become necessary. These would be net in-shipments, over and above the cross-shipping of fresh market winter vegetables and other specialty production. From 1970 onward, the situation would worsen rapidly. What might be expected to happen under such conditions is shown by figure 1, and the projection contained in figure 6. The indicated trend warrants attention. If the assumptions made should prove to be the actual conditions over the next 50 years, the West would be producing only 43 percent of its food needs by 2010. These figures, of course, do not include specialty production and the cross-shipping that necessarily results.

The changing position of the West in relation to the Nation as a whole, in both population and food production, is portrayed in figures 7 and 8.

Feeding People in the Future

The rapidly increasing population of the Western States will result in a need to (1) raise addi-

[1] Footnotes at end of article.

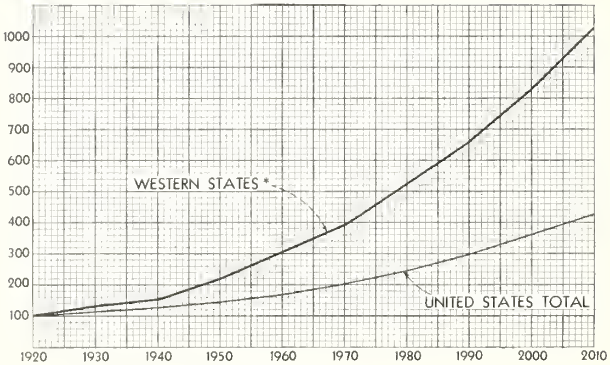


FIGURE 5

tional foods in the West, or (2) ship it in. Shipping some 38 million tons of food (more than 50 trainloads daily), net in-movement, over and above necessary cross-shipping of specialty crops such as fruits and vegetables, and in addition to all other normal freight movement, would present a physical undertaking of considerable proportions, and a staggering burden to our transportation system. This transportation burden, serious in normal times, would become a major problem during a national emergency when transport demands for other purposes would also multiply. To expect so large an area to be dependent on long-distance imports for a major portion of its food supply would be strategically unsound.

Food Production, Requirements, and Prospective Deficit*

Year	Food—retail weight equivalent		
	Requirements [2]	Production [3]	Deficit
	(1,000 tons)	*(1,000 tons)*	*(1,000 tons)*
Historic:			
1920	6, 967	9, 955	Surplus
1930	9, 249	15, 326	Surplus
1940	10, 884	16, 579	Surplus
1950	14, 916	19, 616	Surplus
1960	19, 838	23, 547	Surplus
Estimated:			
1970	25, 561	25, 171	390
1980	33, 718	26, 418	7, 300
1990	42, 630	27, 488	15, 142
2000	53, 612	28, 127	25, 485
2010	66, 483	28, 307	38, 176

FIGURE 6

Footnotes at end of article.

Such a situation would court disaster if destruction or breakdown of the transport system occurred. In addition to the physical problem with its potential dangers, in-shipments of so large a part of the West's food needs from the other areas of the Nation could add a billion and a half dollars per year to the food bill of the people in the West.

A better course would be to raise as much of the food in the West as is possible within the physical and economic limits of the available cropland and water. Also, it would appear to be sound policy to minimize the transportation burden and cost by developing the nearest source of import supplies, the Plains States, as a supplemental food source for the future population of the West. It appears that both sources will be fully needed within the next 50 years.

Food Production and Population

Percent of U.S. Total

Year	Food production		11 western States as percent of United States	
	U.S. total [4]	11 western States [5]	Food production [5]	Population [6]
	1,000 tons	*1,000 tons*	*Percent*	*Percent*
1920	82, 962	9, 955	12	8. 4
1930	95, 790	15, 326	16	9. 7
1940	103, 617	16, 579	16	10. 5
1950	115, 386	19, 616	17	12. 9
1960	130, 816	23, 547	18	15. 2
1970	155, 221	25, 171	16. 2	16. 5
1980	188, 919	26, 418	14. 0	17. 8
1990	229, 506	27, 488	12. 0	18. 6
2000	277, 727	28, 127	10. 1	19. 3
2010	332, 558	28, 307	8. 5	20. 0

FIGURE 7

What Irrigation Can Do

Between the 1939 Census of Agriculture and that of 1959, irrigated land in western farms increased by 6,168,000 acres from 15,714,000 in 1939 to 21,882,000 acres in 1959. This increase is net of the loss of irrigated land to urban built-up uses during the same period, and is due to irrigation development by all sources, public and private. It is this increase in irrigation that has enabled the food-producing capacity of the West to keep abreast of the expanding population to date. In the foregoing analysis, the West's future food needs have been presented along with the prospec-

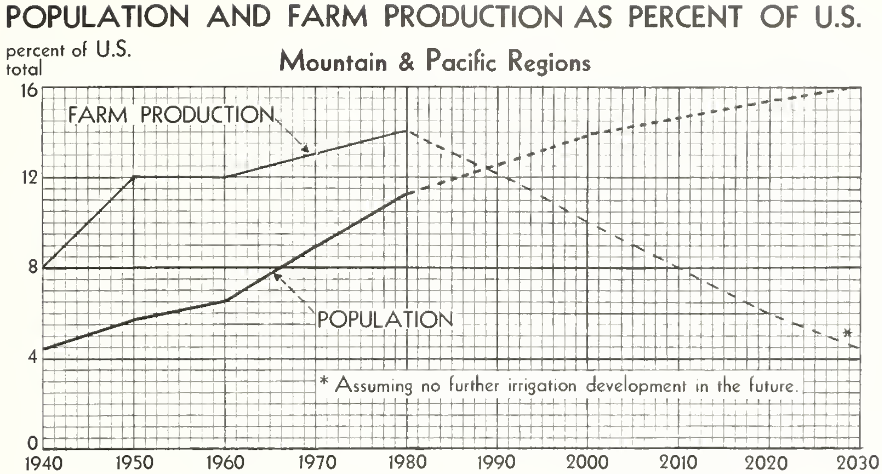


Figure 8

tive food production capacity, assuming that no further irrigation water supplies were developed. Continuing irrigation development, of course, can alter this picture drastically. If the 1939 to 1959 rate of net increase in irrigated land were continued over the next 50 years, 15 million acres would be added to production in the year 2010. This additional productive capacity could cut the prospective food deficit in half, and could reduce the extra freight costs of net in-shipment of food from $1.5 billion to about three-quarters of a billion dollars. To eliminate the prospective future food deficit of the Western States entirely, future irrigation development would be required at double the rate of the past 20 years. This, of course, assumes that sufficient suitable land can be found, and that water can be made available to it, to sustain such a rate of development for the next 50 years.

The role of the Federal and State Governments in continuing irrigation development will become increasingly important in the future. The "cream" of the resources which can be developed by local and private endeavor is now largely gone. The potential that remains is more difficult and expensive to develop; the distances that water must be conveyed are greater, and the reservoirs needed to develop the water are larger. In addition to further development, a good many rescue projects will be needed to maintain present development as ground-water supplies are depleted in many now-prosperous areas of the West. # # #

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*Figure references to the West apply generally to the States of Washington, Oregon, California, Arizona, Nevada, Idaho, Montana, Wyoming, Utah, Colorado, and New Mexico. Maps are by the Department of Agriculture, charts by Bureau of Reclamation.

1910 to 1960, inclusive, taken from 1960 Census of Population, Bureau of the Census, U.S. Department of Commerce; 1970–2000, from Committee Print No. 5, Select Committee on National Water Resources, U.S. Senate, 86th Cong. (1990 interpolated); U.S. total for 2010 from study by Arthur D. Little, Inc., based on Census Series P–25, No. 187, Regional population extrapolated.

Based on U.S. per capita averages; future same as 1960.

From basic data from several USDA publications; future estimates include increasing yields and loss of cropland to urban built-up uses without compensating additions due to further irrigation.

1920–60, computed from basic data taken from several USDA publications: 1970–2010, estimated on basis of needs of estimated population (see fig. 4), assuring self-sufficiency for the United States as a whole.

Percentages for 1920–60, taken from "Trends and Patterns in U.S. Food Consumption," Agriculture Handbook No. 214, USDA, tons computed from percentages; 1970–2010, tonnage figures computed assuming increasing yields (based on "Agriculture Information Bulletin No. 233," USDA) and loss of cropland to urban built-up uses (based on data from "Stat. Bul. 317," USDA), without compensating additions due to further irrigation development; percentages computed from tonnage figures.

Computed from population figures in fig. 3.

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A 30th Birthday . . .

ON THE COLUMBIA BASIN PROJECT

THIRTY years and a few months ago, the first construction started on Grand Coulee Dam, the main feature of the Columbia Basin project in the State of Washington. During that time, industrious Americans built great structures to bring new vigor to the fertile Columbia Basin country. At last fall's celebration, we were reminded that the Basin has been a giant producer of the essential products of life and a reclaimer of abundant natural resources. It is a worthy symbol of American productivity.

The Columbia Basin project has produced over 200 billion kilowatts of energy worth almost a half billion dollars in power revenues, it has saved $62½ million of flood protection to downstream property since 1950, it has supplied 9 million acre-feet of water to fertile farmlands since 1948, and it has contributed a variety of wholesome outdoor recreation to millions of appreciative residents and tourists. In commemoration, this issue of the Reclamation Era includes three articles which point up project contributions from three of its many multiple-purpose standpoints: farming, sport, and scientific improvement. The articles are:

No. 1 Anniversary Article on the Columbia Basin Project . . .

WHETHER IT RAINS OR NOT

At its 71st annual meeting last November, the Washington Dairy Federation set a new precedent in Washington State, one that is likely to be frequently repeated in the future. The federation awarded one of its much-coveted prizes, the Dairy Family Farm Management rotating award, to a farm family on the Columbia Basin irrigation project in central Washington State.

Why was the award unprecedented? Dairying does not ordinarily provide the farmer with a quick cash return. Due to the expense of starting a productive farm enterprise, farmers in a new agricultural area generally start farming with crops that will provide a comparatively quick cash return. Then, as the area grows and prospers, the farmers diversify, cattle become increasingly evident, and full-scale dairy operations may be launched and built up.

Mainly for this reason, the comparatively small strip of matured, well-settled farmland west of the Cascades in Washington State has long been the center of the State's dairy activity. Sixty to 80 percent of the State's milk is produced in that area and much of eastern and central Washington's milk has been trucked over the mountain passes. Now a change in that pattern seems to be in the offing.

The Columbia Basin project is a new and dynamically expanding agricultural area. While its irrigable lands presently numbering in excess of 450,000 acres have been receiving water for less than 10 years, cattle are already making them-

Figure 2.—Award winning family includes, from left to right, Curtis Smith, his son and daughter Gregory and Sherri, and his wife Lucille are presented the Farm Management Award from Washington State University Extension Service Director Calvin Smith at the State Dairy Federations meeting held on November 1, 1963.

selves at home on the project. This rapid maturing process is now highlighted by the official statewide recognition of excellence achieved by the Curtis P. Smith dairy farm in the northeast section of the half-developed million acre project. This is the project's first such recognition.

Laying the groundwork to make this fast and successful transition from sagebrush and sparsley scattered dryland wheat farming about a dozen years ago to more than 50 multicolored, checkerboard-like fields of crops today, has required a carefully laid out development plan. Mr. Smith's fine dairy farm is an excellent example of this process.

In 1948, this farm was purchased by the Government as an experiment farm—one of several such enterprises scattered throughout the project area. They were developed to determine the best irrigation practices as well as to determine the most productive agricultural activity for each area. The findings were subsequently made available to the area's settlers in pamphlets and by extension agents and other professional agriculturalists who, with the experiment farm data at hand, had a good base for their advice.

Since the first major release of irrigation water had not reached the project's lands until 1952, an irrigation well was drilled on the experiment farm in 1947 and construction work began on farm buildings and fields. The lands of the farm consisted mainly of porous, somewhat sandy soils that required careful handling and management. If a successful farm could be established here, the chances for success on most of the project's lands were very good.

Planned Farm

From the first, this land was planned as an irrigated dairy farm with a herd of 25 milk cows. About 106 acres of the 163-acre farm were irrigable. Like the rest of the project area, the growing season was long. Strong winds were common but the weather was fine, with warm to hot summers and fairly mild winters.

Figure 4.—A beautiful collie dog seems to like his award winning masters.

During the early neophyte years of the irrigation project, the farm did indeed prove itself invaluable as an on-the-spot aid to new settlers to the area and agriculturalists in understanding the methods for successful farming of the project. Part of the farm was turned over to cooperating State and Federal agencies for research work which later was published. Agricultural groups, foreign vistors to the project, and neighboring farmers were frequent visitors to the development farm. Still, in a sense, it was not a farm. It was an experiment.

After the farm was on a firm footing, it was leased until 1955 to private farmers under the continued supervision of the administering agencies. In January of that year, Mr. Smith's name was drawn out of a fishbowl during a Government land drawing. Soon after, the control farm and the challenge were his.

When the Smiths came to the basin with their two children, Gregory and Sherri, they brought with them about 18 years of dairy farming experience and a strong desire to trade the smog of suburban Los Angeles for the quiet and spaciousness of the project.

"As much as anything else," Mrs. Smith said, "we wanted to find a better place to raise the children." A five-foot-long board which is almost obscured by a collection of 60 colorful 4–H ribbons and several small gold cups sitting on the fireplace mantel of the comfortable 7-room Smith house today would seem to attest to a job well done in that department also.

In California, the Smiths were part owners of a 170-head dairy herd just on the outskirts of Los Angeles. Feed for the stock had to be purchased; there wasn't room enough on the farm to grow it. Naturally, the transition from a dairy operation of this nature to the 106-acre irrigated farm unit that the Smiths moved onto 8 years ago in central Washington was not easy. Characteristically, however, Mr. Smith optimistically feels that his inexperience in irrigation farming may have really been an asset.

"When I came here I didn't know anything about irrigation farming, but I knew I didn't, so I was more than willing to listen to the advice of my neighbors and the agricultural agencies in the area. "You know," he added, "I'm not too sure that experience is the best teacher to a farmer these days. Particularly if that experience is outdated."

Apparently all of the good advice that he received from his neighbors and agriculturalists went right to Curtis Smith's head, for his land produced, and the farming operation steadily grew and prospered. After only 4 years on the project he was chosen Grant County's Conservation Farmer of the Year on the basis of his implementation of wise soil conservation practices and the overall appearance and productivity of his farm.

"County Benefited"

Three years later in a nomination statement for the position of commissioner of the Washington State Dairy Products Commission, a Grant County extension agent wrote, "We in Grant County have benefited by his honesty, industry, and progressiveness as a leader in the dairy field." Mr. Smith is now Grant County president of that organization. The year following the quoted nomination statement, the Smiths received their current award at the 71st annual meeting of the Washington State Dairymen's Federation.

Good advice, though, no matter how important, certainly cannot take the bulk of credit due to the Smith family. It took a lot of hard work, too. When the Smith family moved onto their unit in

1955, they immediately pitched in, purchased 22 cows and began dairying, and started making grasses grow under their feet and everywhere else.

"Irrigation farming is hard work," Curtis Smith admits, "but it's worth it. Where my wife and I were raised in Nebraska, you needed at least five times as much land to raise yields like I get here—and, too, here I know that I'm going to get a crop every year."

Occasionally during the summer months an elderly uncle of Mr. Smith who still farms in Nebraska, visits the Smiths to vacation and help out with the chores a little. "Every day that he is here he'll look up at the clouds, kind of feel the wind, and then try to predict whether or not we'll have rain." Mr. Smith grins, "He just can't quite understand that it doesn't make a lot of difference whether it rains or not."

Farming, of course, has changed a great deal in the last few years—possibly more than any other single business enterprise. The stereotype of the somewhat quaint, straw-chewing farmer is gone. During his 26 years of dairying, Mr. Smith has seen a lot of this change. For example, before joining the armed services in 1942, he and his wife worked on the same Los Angeles dairy enterprise that they later worked as coowners. "The owner of the dairy had a rather unique way of keeping records," Mr. Smith recalls, "He used to keep a pocketful of cardboard milk bottle caps at hand, and when he checked the herd he'd just scribble any appropriate notes on one of those caps. Then at the end of the day he'd empty his collection of bottle caps into a cigar box. That was his filing system."

It may have worked 20 years ago but it is doubtful how efficient such a bookkeeping system would be today. There are now a total of 170 cows on the Smith farm and a thorough individual record is kept on each head. On the basis of these records he is able to cull out low-producing stock, feed his stock selectively according to their production, select his best breeding stock, and properly evaluate his management practices. On top of this particular stack of paperwork, tax records and a whole multitude of other records make the white-collar workers' tools as important to Curtis Smith as his books and tractors. Its very newness is an asset to the project in this department. New farming techniques and ideas are not resisted simply because they are different—they are tested, and, if useful, adopted.

Oh, yes; the weekly journey to town for supplies and social contacts is also just plain folklore with the Smiths. A year after their arrival in the basin, Mr. Smith was elected president of the Columbia Basin Milk Producers Association, a co-op through which he markets his milk. He is a 4–H Club leader, a director of the Grant County Dairy Herd Improvement Association, a director on the Quincy-Columbia Basin Irrigation District Board, and—in short, a very active and valuable man to his community. (*Continued on p. 21.*)

Figure 3.—Alfalfa hay is chief item on the menu for Smith's cattle. His irrigated land produces at about 7 tons per acre.

HOW TO FRUSTRATE WEEDS

Millions of weeds that grow in canals in the Columbia Basin project, might, if they had voices give utterance to on last word—"GAS!"—then wilt and die.

Something like that, but, of course without the utterance, has happened. And as a result, water is rescued from weeds and more water is made available for irrigated lands.

About 50 different crops grown in the irrigated project will directly benefit from the discovery of the effects of very low concentrations of a powerful and pungent chemical that has been tested on the project's canals the last couple of years. It controls the growth of aquatic weeds.

The chemical's name is *acrylaldehyde*, commonly called *acrolein*. To the layman with military experience, standing downwind of a barrel of it when it is opened, however, it is also unmistakably identifiable as a very effective tear gas. Diluted in water as a herbicide, it is harmless to animals.

Figure 2 (P222–116–44997).—John Walker, center, of the Bureau's Boise office works with a Shell representative in accurately measuring the rate of the chemical's application by weighing.

Of course, the Columbia Basin project is not the first place where this chemical has been used as a herbicide against aquatic weeds. In the Florida Everglades, for example, the potent chemical was used to kill floating aquatic water weeds. But always before it had been used in comparatively substantial quantities, and, at $175 a barrel, these treatments were not inexpensive.

In 1962 Mr. John Walker of the Bureau's Regional Office in Boise, Idaho, who had used the chemical on the Black Canyon project in Notus, Idaho, suggested that it be used in very low concentrations on an experimental basis on the Columbia Basin project. It was Mr. Walker's idea that applications of *acrolein*, the chemical's common name, as low as one part to a million parts water might do the job at a substantial savings.

A team of Bureau agronomists with the assistance of the Department of Agriculture's Research Service and Mr. R. Reider of Shell Chemical Corp. of Yakima, Wash., got together and the first low concentration application of the chemical was tried on the project on May 16, 1962. The larger of the two lateral canals chosen for the tests was 13 miles long and had a capacity flow of about 89 cubic feet per second. The other canal was 5 miles long and had a capacity flow of 35 cubic feet per second.

Two methods of application were tried. On the larger canal, the chemical was fed into the canal continuously at a rate of one to three parts *acrolein* to a million parts of water. On the smaller canal, the pungent chemical was fed into the canal at a rate of about 7 to 21 parts chemical to a million parts of water for 24 hours once a week.

The results successfully upset the carefully planned experiments. Prior to the tests, both of

Figure 1.—Chemical is fed into a project canal by Adam Focht, Assistant Watermaster. Concentrations as low as one part Aerolein to ten million parts water were successful.

these canals had been infested with a young growth of Sago pondweed, a long tenacious threadlike water weed which can easily attain a length of 20 feet. The result of millions of these streaming weeds in an irrigation canal, at the minimum, means a decided lessening of the canal's capacity and can mean the loss of a canal when the water is so cramped for room that it overflows its banks.

Numerous methods of controlling weeds have been tried, but none has been completely satisfactory. Chaining—dragging a heavy metal chain along the bottom and sides of a canal—is costly and fills the water with segments of torn plants which can plug downstream irrigation structures. Dewatering the canals to kill the weeds by withholding their primary subsistence can be 100 percent effective, until the plants sprout again several weeks later, but dewatering also deprives crops of that same much-needed sustenance. And, although other types of chemicals such as aromatic solvents or copper sulfate had been used with varying degrees of success, the cost of this chemical treatment was very high.

But within 3 days after the continuous application of *acrolein* began on the larger canal, the growth of the young pondweeds was controlled. What was particularly startling, though, was that the pondweeds were being effectively controlled, not only at the point of application but even on the farthest reaches of the canal. Accordingly, the carefully planned rate of application was changed—reduced from one to three parts to a million parts of water to 0.1 part chemical to a million parts of water. This would be about 4 ounces of chemical per acre-foot of water.

The frequency of application was reduced from periods of 24 hours once a week to periods of 48 hours once every 3 weeks. The amount of *acrolein* used was so slight that in some of the tested areas, laboratory tests of the treated water failed to indicate its presence.

Perhaps there was no audible outcry from the pondweed along the length of the 13-mile-long canal when they detected the first minute traces of the chemical in the water, but the effects on the plants were soon plainly visible.

Initially the normally green-colored plant turned reddish brown. Then the plant's leaves became translucent and lax, and the greater exposed portion of the plant deteriorated. In the very small quantities in which the chemical was used, the plant's roots were seldom killed, but its growth was definitely forestalled. A complete kill takes so much more chemical that it has commonly been found more economical to control weed growth than to attempt to eradicate it.

Between treatments the water weeds, of course, truly grew like weeds; about 8 to 10 inches, but the weeds situation on these test reaches was under control. Although comparable results were

obtained on the smaller canal, for some as yet unexplainable reason, the chemical was not quite as effective.

Due to the very small quantity of chemical used on these tests, the mechanics of the method of application were necessarily delicate. Gravity applications were made through polyethylene tubing and hypodermic needles. The exact amount of the chemical used was checked by periodically weighing the barrel which held the *acrolein*.

Armed with a year's favorable experience with the chemical, under the supervision of Del Suggs, the Columbia Basin project's management agronomist, five more canal reaches were added to the two test reaches for the chemical treatment in 1963. The successes were similar to the previous year.

There were problems of course—for example, since it was imperative that the flow of chemical be kept constant, the 55-gallon drum in which the chemical came had to be vented; air bubbles in the delivery tubes impeded accurate flow measurements. Then, too, since *acrolein* so readily vaporizes into a tear-producing gas when it was necessary to work downwind from an opened drum of the chemical, a gas mask was a must. While handling the barrels of chemical, it was also found advisable to keep a supply of fresh water handy as the liquid has a temporarily burning effect on skin.

But these comparatively minor inconveniences were found to be far outweighed by this odiferous chemical's benefits. At the end of the 1963 irrigation season in October, it was estimated that the total cost for the *acrolein* treatment on the reaches of test canals was at least a third cheaper than aromatic solvent treatment methods and at least four times cheaper than mechanical chaining methods.

On several of the treated canals, the water level dropped several inches once the impeding weeds were controlled. This means that these canals are now capable of conveying more water for more crops.

On smaller canals, as previously mentioned, *acrolein* seems to be only little more effective than other chemicals, but on the larger canals this tear-gas-like chemical, and indirectly, the project's crops appear to have a rosy future—and the water weeds a frustrating one. # # #

CONSERVATION AWARD
for Life of Service

William E. Welsh, whose work for the past 16 years as Secretary-Manager of the National Reclamation Association is recognized and respected throughout the entire West, was presented the Conservation Service Award of the Department of the Interior by Commissioner Floyd E. Dominy at the annual convention of the NRA held in October 1963 at Sun Valley, Idaho.

Mr. Welsh was presented the award for his nearly a half century of tireless work toward the full development of water and land resources in terms of the optimum benefits for all. Twice an employee of the Reclamation Service, he has served in his NRA post during the years of greatest growth and emphasis on multiple-purpose reclamation.

In the Boise, Idaho, area, having matriculated in the College of Idaho in 1914 where he was prominent in debate and literary activities, he worked his way through school as a river rider during summer vacations. Before and after serving in the U.S. Navy until the end of World War I, he served in the U.S. Reclamation Service both at Bruneau, N. Mex., and at Kuna, Idaho. Also prior to accepting his NRA post in 1947 with headquarters in Washington, D.C., he held the position of superintendent of the Farmers Ditch Co. and served for 21 years as watermaster for the Boise River.

In 1952, the College of Idaho bestowed an honorary degree of master of irrigation upon Mr. Welsh in recognition of his many accomplishments in furthering irrigation and reclamation development. While living in the Boise Valley, Mr. Welsh served many years on the board of trustees—several in the capacity of president of the board—of the College of Idaho. # # #

No. 3 Anniversary Article on the Columbia Basin Project . . .

GOOD HUNTING IS INCREASING

IN THE fall of 1951, the first major release of irrigation water flowed toward the waiting lands of the Columbia Basin project, in central Washington State, from the project's equalizing reservoir—Banks Lake—located just south of Grand Coulee Dam.

Since that time, hunting prospects on the Columbia Basin project have increased yearly as each irrigation season brought more croplands, which, in turn, provided more feed and cover to upland game birds and waterfowl. More water also meant more resting areas and breeding grounds for ducks and geese.

Although nature had a big hand in making these large harvests of upland game and waterfowl available to the many thousands of hunters who come to the project area every hunting season, the growth of this fine hunting was the result of careful planning.

The many miles of hardtopped roads that are necessary to every successful reclamation project have made the project's fields and waters accessible to sportsmen. As part of its regular game planting program to insure a good stock of birds, the Washington State Department of Game last fall planted a total of about 2,500 mature cock pheasants on public lands in the project area by the time the season ended.

In the first accompanying photograph, pheasants are seen exploding out of their carrying cages during a release in the Steamboat Rock area adjacent to Banks Lake, the project's equalizing reservoir. Raymond Rumbolz, game farm assistant at the State's rearing farm in Kennewick, is encouraging a few laggards to fly the coop. Two hundred and sixty mature pheasants were released last October.

Yearly plantings of upland birds are released in the project area each year by the department

of game to insure a thriving crop of game birds. Also, in an effort to provide good cover for wildfowl, the department of game has planted more than 2 million trees and shrubs in the Columbia Basin in the last 10 years.

Recognizing the importance of maintaining good relations between farmers and hunters, about 100,000 irrigated acres of basin lands are now under the farmer-sportsmen program. This department of game program encourages farmers to give hunters access to their lands by providing free signs such as "Hunting by Permission." Participation in the program increased 20% this last year.

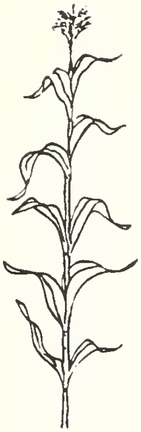
In the early development stages of the project, the Bureau of Reclamation transferred large areas of its land and water to Washington State and national agencies to administrate for recreation and fish and wildlife purposes. One such area is the Columbia National Wildlife Refuge, located near the center of the project, which was turned over to the Bureau of Sport Fisheries and Wildlife in 1955.

"Before the Columbia Basin project, the present Columbia National Wildlife Refuge area was little more than a large dry area of rolling hills and cliffs and a single creek," says Columbia National Refuge Manager Phil A. Lenhenbauer, "but now that has all changed. In 1962 about 4,200 hunters killed almost 8,000 ducks on the refuge and in the early part of the current season, these figures appear to be even higher than last." Mr. Lenhenbauer also stated that at least 75 percent of the hunters at the refuge come from the coast—more than 150 miles to the west.

In addition to the full cooperation that the Bureau of Reclamation extends to these agencies, as previously mentioned, the Columbia Basin project also makes the basic contribution to its teeming game, for it provides them with food and water and shelter. Thousands of acres of new irrigable land are added to the growing project each year. More water is consequently needed to irrigate these new acres of crops—water which will also provide additional rest and breeding areas for waterfowl.

There are now about 100 bodies of water on the Columbia Basin project, and the crops planted on these new acres will provide more food for more wildlife. # # #

Figure 2.—A couple of hunters heading home with a good duck kill after a visit to Potholes Reservoir. 35,000 waterfowl were taken from the game range here last year.



CORN SUCCEEDS IN IRRIGATED FORAGE MIXTURES

by Lionel Harris*
Superintendent, Scotts Bluff Experiment Station, University of Nebraska at Lincoln

CORN has replaced low-profit oat and barley companion crops in establishing alfalfa and alfalfa-grass mixtures at the University of Nebraska's Scotts Bluff Experiment Station.

Corn yields of 100 to 130 bushels per acre were produced during the year alfalfa was established. In following years, alfalfa yields ranged from 5 to 7 tons per acre.

The mixing first was tried successfully on level bench terraces at the Scotts Bluff Station. Tests showed that alfalfa could be established in corn yielding near maximum with 20,000 corn plants per acre in rows spaced 42 inches apart, on level bench terraces. In corn rows spaced 30 inches apart, the alfalfa did not get a good start, and in corn rows 60 inches apart, alfalfa grew well, but corn yield went down.[1]

Later, with careful irrigation management, the practice proved successful on sloping land. It is now standard practice for establishing alfalfa and alfalfa-grass mixtures at the experiment station.

Procedure of Establishment

At Scotts Bluff, the procedure to successfully establish alfalfa and alfalfa-grass mixtures in corn on sloping land begins with fertilizer.

Fertilizer was applied to produce a maximum yield of corn and to supply adequate phosphorus for alfalfa in later years. This required large applications of nitrogen, 100 to 150 pounds per acre, and moderate rates of phosphorus applied on the basis of soil tests 60 to 80 pounds (of P_2O_5) per acre. Zinc at 10 pounds per acre was applied where it was needed. Manure was used in some instances to supply part of the required fertilizer nutrients. All fertilizer was broadcast and plowed under.

Seed beds were prepared shortly before corn planting time, by plowing with a packer pulled behind the plow. This operation killed early spring weed growth.

Corn was planted May 1 to 10 in rows spaced 42 inches apart, and with kernels in the row spaced to produce a population of 20,000 to 24,000 corn plants per acre.

Early weed growth was controlled with a rotary hoe, and cultivator. Area between corn rows was kept as level as possible in all cultivation operations. During some years broadleaf weeds were controlled with 2,4-D spray applied when the corn was 6 to 8 inches tall.

Figure 3.—Shallow ditches between corn rows carry a small stream of irrigation water.

[1] O. W. Howe, *Crops & Soils*, Vol. 12, No. 8, 1960.

*The author recognizes the help of Herb Ullrich, farm manager, in developing procedures described in this article. The article is an expanded version of an article published in the Spring, 1962 issue of the *Nebraska Experiment Station Quarterly* under the title, "Corn Good Companion Crop."

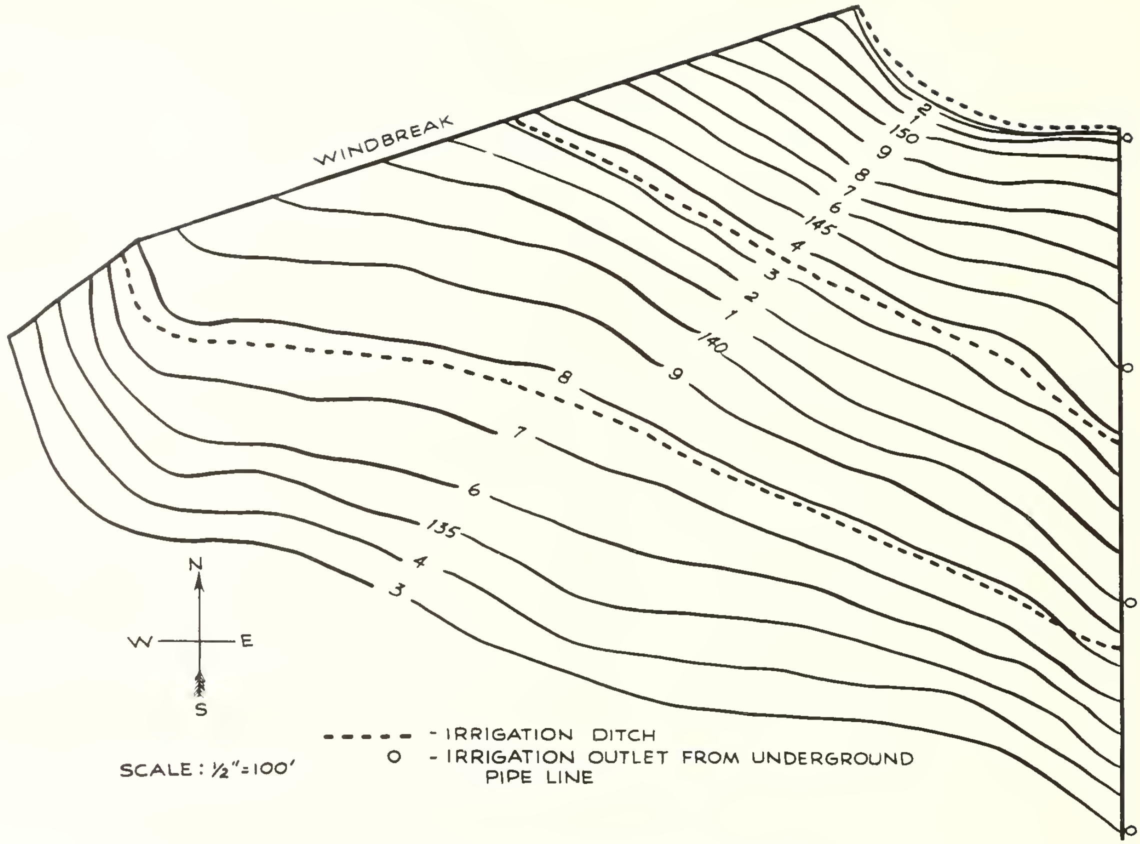


Figure 4.—Contour map of field planted to corn and alfalfa.

Alfalfa or alfalfa-grass mixtures were seeded in the corn about the last week in June when corn growth was 12 to 16 inches tall.

Production was satisfactory from seeding alfalfa through a grass seeder attachment on a high press wheel grain drill. (See fig. 2.) Disks and wheels on the drill were removed where they might damage the growing corn.

Also, alfalfa and grass were mixed and seeded broadcast through a fertilizer spreader, with a finger weeder pulled behind to lightly mix the seed with the soil. Grass and alfalfa seed should be mixed occasionally in the spreader to avoid separation.

Immediately after seeding the alfalfa or alfalfa-grass mixture, two small ditches were made between each two rows of corn to carry irrigation water. (See p. 21.) Alfalfa and grass seed germinate quickly after rain during warm weather of late June. Therefore, the ditching operation after planting should not be delayed, especially on sloping land. Ditches were not necessary to facilitate irrigation on level bench terraces.

Irrigation

The idea of irrigating an alfalfa field rather than a cornfield on sloping land was followed in establishing irigation procedure for production of the alfalfa-grass-corn combination of crops. Contour irrigation laterals were constructed through the cornfield at intervals of 250 to 300

Figure 1.—First growth of alfalfa and grass seeded in corn on sloping land the previous year. Heavy roller was used in early spring to level corn row ridges.

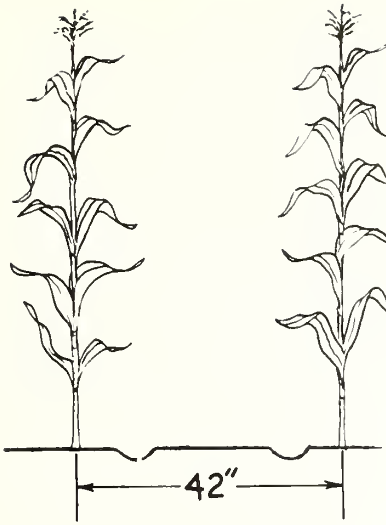


Figure 2.—Drill used to seed alfalfa in corn.

feet. (See sketch on p. 20.) Length of irrigation runs should be short on sandy soil and steep slopes, but may be longer on heavy soils and moderate slopes. The length of run should be short enough to prevent soil erosion in the irrigation process.

Small siphon tubes ¾ to 1 inch in diameter were used to deliver water from the contour lateral into the shallow ditches between corn rows. The small streams of water delivered in this manner over the short runs soaked the entire area without serious erosion, and with very little runoff.

Good yields of corn were produced and alfalfa and grass were established in the cornfield with three well-timed irrigations. It should be observed that the alfalfa and grass were seeded in corn shortly before this crop needed its first irrigation. Quick germination, and rapid growth of alfalfa and grass seedlings, occurred shortly after water was applied during warm July weather. Corn plants provided protective shade for the young seedlings against excessive heat, yet did not exclude light to their great detriment. Later on, the growth of corn overshadowed the alfalfa and grass, but not before these crops were established perennials.

Management Important

Irrigation management will determine success in establishing alfalfa and grass in irrigated corn on sloping land. The practice involves more work and planning, but returns have paid large dividends, compared with other methods of establishing these crops.

Soil erosion and over irrigation on the upper ends of fields were eliminated by careful irrigation.

As yet, only a few farmers have adopted this mixing combination because of the detailed work needed for irrigation and planning. However, the system offers economic and other advantages wherever corn, alfalfa, and grass are grown under irrigation. When these advantages are recognized and understood, the practice undoubtedly will spread. # # #

RAIN OR NOT (*continued from p. 10*)

And the rest of the Smith family have followed suit. His wife, Lucille, in addition to the housework and cooking for so active a family, is a member of the Dairy Wives of Grant County.

His son, Greg, 16, was chosen as a judge for the county 4–H team in 1962, and that same year, Sherri, 12, was picked as Junior Champion in Dairy Fitting and Showing at the county fair. This is in addition to the activities that won dozens of 4–H ribbons and awards. "The children just wouldn't have had the opportunity to participate in these things where we lived before," Mrs. Smith said, "Here, it is the chief interest in the community."

Today the Smiths own 200 acres of land—they bought a second nearby farm unit in 1960 to accommodate their rapidly expanding farming enterprise. With the help of his son and one full-time man, Mr. Smith now cultivates 180 irrigated acres.

Since each of his 65 milk cows alone consumes about 6 tons of hay a year, his farm's soil would seem to pretty much have its job cut out for it. But the soil, when properly treated, is apparently as capable as the family, producing more than enough forage for the stock—about 10 percent of it is sold off the farm—and a substantial acreage of wheat and potatoes.

Curtis Smith and his family are truly innovators in dairying on the Columbia Basin project. Within 8 years they have established a substantial dairy enterprise that is a credit to this country on the youngest piece of booming farming real estate in the State.

And his opinion of that real estate? "What my wife and I recall of dryland farming is drought and wind. We really appreciate this irrigation project." # # #

A NEW CROP GROWS
On an Old Project

A GRAND old Reclamation project is contributing, in a special way, to the quenching of the Nation's thirst to the tune of a million dollars per year. And not just with water.

In 1962, 560,240 bushels of Moravian malting barley was grown by the Uncompahgre project farmers for manufacturing of beer by the Adolph Coors Co.

Moravian barley is a specialty crop new to the 60-year-old Uncompahgre project and one which holds great promise for nearby proposed Reclamation projects—the Fruitland Mesa and Bostwick Park projects.

Specialty crops are the hallmark of Federal Reclamation projects. Although they occupy only about 16 percent of the cropped land, they provide approximately 40 percent of the farmer's income.

Moravian barley is a far cry from the luscious fruit crops and sturdy vegetable crops that people usually think of when crops from the irrigated West are mentioned. The identity of this crop is lost as a major ingredient of fine American beer.

With a name sounding like something out of the "Vienna Woods," Moravian barley is just about that. In 1949, Adolph Coors Co. received a shipment of premium malt from the Province of Moravia, Czechoslovakia (a former Province of Austria). Included was a small packet of seed from the barley crop which produced malt. A few of these seeds were planted in a private garden in Golden, Colo., to test their adaptability to growing conditions there. Results were encouraging and from that small planting has grown a new specialty crop for western irrigated farms.

In 1962, the Bureau reports that crop production on the Uncompahgre project area amounted to $5,146,822. Adolph Coors Co. figures show that $910,000 of malting barley was produced in the area that year. This barley requires a favorable growing climate with adequate amounts of moisture. Uncompahgre, with its generous supply of water, its mild daytime temperatures, and

cool nights is just what the farmer ordered, and the barley thrives there.

Moravian barley is a midseason-to-late grain with stiff straw growing 24 to 30 inches high. The kernels are plump and lend themselves well to the malting process.

Farmers receive, at present, $3.25 per 100 for barley of malting quality. It must meet high malting standards which the Moravian does. A bushel weighs 50 to 52 pounds.

Adolph Coors Co. produces certified Moravian seed which is grown from seed stock by the Colorado State University. Growers are contracted to produce foundation, registered, and certified seed. They are paid $4.50 per 100 pounds by the company for the seed. Malt barley producers buy treated certified Moravian seed for $6 per 100 pounds for Coors. All barley produced from certified Moravian seed is purchased for malting purposes. Generally, seed is sold only to growers who are malt barley producers.

This special malt barley is planted from March 15 to April 15, with the earlier plantings preferred. A regular grain drill is used for planting, the company recommending 90 to 100 pounds of seed per acre. Field men are available to the farmer on call to advise them in any phase of production, including disease and insect control. Irrigation dates and amounts of water to apply are suggested. Normally, five irrigations are adequate.

All Moravian is harvested with combines when moisture content of the grain is 14 percent or less. If 95 percent of the grain will remain on a special slotted screen, the field price of $3.25 per 100 pounds is paid the grower. Malting barley must not be mechanically damaged over 2 percent. After the malting process, the remaining residue is dried, mixed with barley screenings, sprouts, and some yeast. This material is pelleted and sold to beef feeders and to dairy men as feed supplements.

The Uncompahgre project, on which this new enterprise developed, is one of the first Reclamation projects in the United States. It was authorized by the Secretary of the Interior on March 14, 1903, and consists of a diversion dam on the Gunnison River, Gunnison Tunnel, Taylor Park Dam and Reservoir, canals, diversion structures, miscellaneous tunnels, and other structures. The cost of constructing these facilities is repayable by the Uncompahgre Valley Water Users Association.

So great has been the success of the Moravian barley program on the Uncompahgre project that the Adolph Coors Co. envisions a 2½-million-bushel program in the near future. Company officials are looking with great interest toward the Bostwick Park and Fruitland Mesa areas and the proposed Reclamation projects for future expansion. As the expected 10–20 percent per year Moravian expansion program proceeds, more areas will be required for its production and a greater number of farmers will benefit from the proceeds of the Moravian barley enterprise already thriving on the Uncompahgre project. # # #

gure 1.—Irrigator J. B. Adams oks over this field of high quality oravian barley. The Coors processing plant and warehouse near elta, Colorado, is shown in the ackground.

gure 2.—Moravian barley nearg maturity is being inspected in e photo on p. 22 by C. W. McCart, anager of the company's grain orage plant.

MAJOR RECENT CONTRACT AWARDS

Specification No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DS-5944	Missouri River Basin, Mont.-Wyo.	Oct. 22	Four electrohydraulic-type governors for hydraulic turbines for Yellowtail powerplant, schedule 2. (Negotiated contract.)	ASEA Electric, Inc., New York, N.Y.	$162, 62[illegible]
DS-5988	Colorado River front work and levee system, Calif.-Ariz.	Oct. 10	Six pump-turbines, six 54-inch butterfly valves, and one valve operating system for Senator Wash pumping-generating plant.	Fairbanks, Morse & Co., Hydraulic and Special Projects Division, Denver, Colo.	287, 76[illegible]
DC-5993	Missouri River Basin, Mont.	Oct. 31	Construction of the 61-mile Custer-Yellowtail section of the Yellowtail-Dawson County 230-kv transmission line.	Lindberg Construction Co., Jamestown, N. Dak.	1, 659, 79[illegible]
DC-6000	Canadian River, Tex.	Nov. 12	Construction of 90 miles of concrete pipelines for main aqueduct, schedule 3.	Cen-Vi-Ro of Texas, Inc., New York, N.Y.	12, 464, 22[illegible]
DC-6004	The Dalles, Oreg.	Oct. 3	Construction of 45 miles of pipelines, including reservoirs and pumping plants, for lateral distribution system.	Beasley Engineering Co., Emeryville, Calif.	3, 051, 81[illegible]
DC-6007	Missouri River Basin, Iowa.	Oct. 14	Construction of stage 02 additions to Creston substation and control equipment additions to Denison substation.	W. G. Dale Electric Co., Cheyenne, Wyo.	285, 83[illegible]
DC-6013	Colorado River storage, Colo.	Dec. 13	Construction of 84.5 miles of Curecanti-Poncha section of Curecanti-Midway 230-kv transmission line.	Paul Hardeman, Inc., Stanton, Calif.	3, 737, 15[illegible]
DC-6018	Missouri River Basin, Wyo.	Nov. 20	Construction of the 33.37-mile Glendo-Lusk 115-kv transmission line.	Dominion Construction Co., Lincoln, Nebr.	357, 20[illegible]
DC-6021	Missouri River Basin, S. Dak.	Dec. 10	Construction of stage 02 additions to Mission and Martin substations.	William A. Pearson, Rapid City, S. Dak.	140, 14[illegible]
DS-6025	Missouri River Basin, Mont.	Dec. 2	Four hoists for 9.93-foot by 18.98-foot fixed-wheel gates for penstock intakes at Yellowtail dam.	Galland-Henning Mfg. Co., Milwaukee, Wis.	168, 88[illegible]
DC-6026	Emery County, Utah.	Dec. 11	Construction of 4.4 miles of asphalt-membrane lined and 7.3 miles unlined Cottonwood Creek-Huntington canal, Sta. 162+91.10 to 846+00.	R. A. Heintz Construction Co., Portland, Oreg.	1, 578, 85[illegible]
100C-640	The Dalles, Oreg.	Dec. 3	Construction of 6.91 miles of 12.5-kv electrical distribution and control lines.	Mark W. Chisum, Inc., Portland, Oreg.	132, 99[illegible]
100C-651	Columbia Basin, Wash.	Nov. 27	Construction of 8.5 miles of buried pipe drains and 0.7 mile unlined open ditch drain for D78-96 drainage system, block 78.	B & B Plumbing & Heating, Inc. Anacortes, Wash.	138, 42[illegible]
300C-195	Delivery of water to Mexico, Ariz.	Oct. 25	Construction of 8.9 miles of channel lining and modification of structures for Wellton-Mohawk conveyance channel, utilizing concrete-filled concrete blocks, schedule 2.	Karl A. Dennis, dba, Dennis Construction Co., Yuma, Ariz.	169, 60[illegible]
400C-224	Provo River, Utah	Oct. 10	Revision of Provo River channel, mile 29.6 to 35.6 below Duchesne tunnel.	United Engineers, Inc., Murray, Utah.	414, 61[illegible]
400C-240	Colorado River storage, Colo.	Oct. 18	Construction of a warehouse and a storage garage for Montrose power operations center.	Lluts Construction Co., Inc., Pueblo, Colo.	298, 63[illegible]
500C-137	Middle Rio Grande, N. Mex.	Nov. 8	Clearing 6,428 acres for Belen Unit 5 channelization, schedule 4.	N. H. Roane, and Jean Roane, Campbellton, Tex.	288, 99[illegible]
600C-202	Missouri River Basin, Mont.-Wyo.	Oct. 15	Clearing parts 1 and 2 of Yellowtail reservoir, schedules 1 and 2.	E. R. McKee Construction Co., Hulbert, Okla.	597, 55[illegible]
600C-202	do	do	Clearing part 5 of Yellowtail reservoir, schedule 3.	E. D. Robinson, Clearing Contractor, Cascade, Colo.	126, 24[illegible]
602C-42	Missouri River Basin, S. Dak.	Oct. 14	Furnishing and applying buried asphaltic membrane lining for reaches of Angostura canal and laterals 11.4 and 11.4A.	Hicks Construction Co., Hot Springs, S. Dak.	174, 64[illegible]
701C-589	Missouri River Basin, Neb.	Oct. 3	Construction of 1.4 miles of Superior floodway channel 32-1-6.	Grosshans & Petersen, Inc., Marysville, Kans.	120, 48[illegible]
DC-5994	Missouri River Basin, Iowa.	Dec. 18	Construction of stage 04A and 05 additions to Sioux City substation.	Power Engineering Co., Inc., Sioux City, Iowa.	411, 00[illegible]
DC-6020	Parker-Davis, Ariz.	Dec. 20	Construction of stage 02 additions to Cochise substation.	The Tide Co., Tacoma, Wash.	199, 98[illegible]
DS-6027	Navajo Indian irrigation, N. Mex.	Dec. 16	Aerial photography and topographic maps for East Chaco area (negotiated contract).	Aero Service Corp., Philadelphia, Pa.	164, 14[illegible]

Major Construction and Materials for Which Bids Will Be Requested Through February 1964—Continued

Project	Description of work or material
MRBP, Wyoming	Stage 02 additions to the North Cody Substation will consist of removing wood-pole structures; constructing concrete foundations; furnishing and erecting steel structures; removing and reinstalling structure-mounted electrical equipment; and furnishing and installing associated electrical equipment. Near Cody.
Navajo Indian irrigation, New Mexico.	Constructing a tunnel headworks structure consisting of a reinforced-concrete trashrack structure with metal trashrack, and a reinforced-concrete gate shaft about 140-ft high with two 9- by 12-ft fixed-wheel gates and two 9- by 12-ft radial gates with hoists, and about 2 miles of concrete-lined tunnel of 19-ft-diameter horseshoe shape, or 19.5-ft-diameter circular. Near Farmington.
Rio Grande, New Mexico.	Constructing a residence, a shop and warehouse building, about 3 miles of roads, and recreational facilities. Near Truth or Consequences.
Rogue River Basin, Oregon.	Preparing subgrade and applying pneumatic mortar lining to about 9,100 lin ft of existing laterals with bottom width varying from 12 to 4 ft. Near Medford.
San Juan-Chama, New Mexico.	Constructing about 13 miles of concrete-lined tunnel of 10-ft 7-in. diameter horseshoe shape or 10-ft 10-in. diameter circular. Near Chama.
Seedskadee, Wyoming	Clearing, leveling, constructing irrigation ditches and fencing for a 375-acre farm; installing a three unit river pumping station; moving two relocat able residences and two prefabricated meta garages to farm from government camp; and pro viding culinary water supply and sewage dis posal facilities. About 35 miles northwest o Green River.
Weber Basin, Utah	Constructing East Canyon Dam, a 35,000-cu-y concrete arch structure about 260-ft high an 450-ft long, with an uncontrolled crest spillway i left abutment, and an outlet works consisting o a 2-ft 9-in. by 2-ft 9-in. conduit through the dan controlled by high-pressure gates. Work wil also include relocating about 2.5 miles of count road and about 2 miles of access road. On Eas Canyon Creek about 11 miles southeast of Mor gan.
Do	Constructing about 1,800 lin ft of 12-in.-diamete pipeline and one 3-cfs pumping plant. Pipelin will be constructed of pretensioned concrete-stee cylinder pipe or mortar-lined and coated or mor tar-lined and wrapped steel pipe or asbestos cement pipe at contractor's option. Nea Bountiful.

U. S. GOVERNMENT PRINTING OFFICE : 1964 O - 715-975

Major Construction and Materials for Which Bids Will Be Requested Through February 1964*

Project	Description of work or material
Arbuckle, Okla.	Constructing Arbuckle Dam, a 2,750,000-cu-yd earthfill structure, about 140 ft high and 2,000 ft long, with a glory hole intake spillway, a 9-ft 6-in. diameter cut-and-cover conduit, and a stilling basin. The river and municipal outlets will be 7-ft 6-in. and 3-ft 0-in. diameter cut-and-cover conduits respectively. On Rock Creek about 6 miles southwest of Sulphur.
Boulder Canyon, Nev. and Ariz.	Installing Transformer "Z" at the Hoover Dam switchyard will consist of constructing reinforced-concrete foundations; installing a 25,000-kva power transformer, bus structure, metering and relaying cubicle; and constructing a structural-steel takeoff structure on the roof of the Nevada powerplant. The installation will consist of lowering the transformer by means of a 150-ton cableway and drifting it onto the powerplant roof. The transformer will then be skidded about 500 ft along the roof to the point of installation. Work will also include constructing concrete footings; furnishing and erecting steel towers; and furnishing and stringing conductors for about 0.43 mile of 69-kv transmission line; constructing concrete foundations; furnishing and erecting steel structures; and installing miscellaneous electrical equipment to modify the existing 69-kv switchyard.
Canadian River, Texas	Clearing trees, brush, and buildings from the Sanford Reservoir area. Near Fritch.
Do	Constructing four indoor-type pumping plants each having a 43-ft-wide by 151-ft-long reinforced-concrete substructure, with five motor-driven pumping units having a total capacity of 683.4 cfs. The plants will have structural-steel superstructures supporting either 5- or 7.5-ton cranes and will be enclosed with insulated metal siding. Between Sanford and Amarillo.
Central Valley, Calif.	Constructing the Los Banos Creek Detention Dam, a 2,100,000-cu-yd earthfill structure about 154 ft high and 1,370 ft long, with a chute-type spillway in the left abutment and an outlet works consisting of an intake structure, a concrete-lined tunnel, control structure, and stilling basin. Work will also include earthwork and surfacing for about 2 miles of access road and constructing a service road to the control structure. On Los Banos Creek, 7 miles southwest of Los Banos.
Do	Work for Red Bank Creek channel improvement will consist of constructing a protective dike adjacent to Red Bank Creek; and stabilization along the Sacramento River near the Riverside Estates. Alternative bids will be accepted on the dike and the bank stabilization for riprap or soil-cement slope protection.
Colo. River front work and levee system, Calif.	Constructing foundations and furnishing and erecting about 20 miles of wood-pole, 69-kv transmission line from Gila Substation to Senator Wash Pumping Plant, and constructing 69-kv addition to Gila Substation. Northwest of Yuma.
Do	Constructing concrete conveyance channels for discharge of 12 drainage wells. Near Yuma.
Colo. River storage and Parker-Davis, Ariz.	Stage 02 additions to Mesa Substation will consist of furnishing and installing three 230-kv breakers; stage 03 additions will consist of constructing concrete foundations; furnishing and erecting steel structures; furnishing two 230-kv breakers, one of which is to be installed; and furnishing and installing associated electrical equipment.
Colo. River storage, Colo.	Clearing trees, brush, structures, and other improvements from about 9,180 acres of reservoir area. Twenty miles west of Gunnison.
Do	Constructing a 100- by 155-ft maintenance shop, a 60- by 155-ft service garage, and a small pumphouse with two 100-hp vertical turbine pumps. at Montrose.
Do	Earthwork and structures for about 17 miles of Gunnison County Road No. 7 relocation. About 10 miles west of Gunnison.
Do	Constructing a 1,500-kva substation and installing an underground distribution system. At Montrose.
Do	One 300-ton-capacity overhead traveling crane for Morrow Point powerplant. Estimated weight: 350,000 lb.
Do	Two 101,880-ft-lb cabinet-type actuator governors for regulating the speed of two 41,500-hp turbines at Blue Mesa powerplant.
Columbia Basin, Wash.	Constructing about 60 miles of open laterals with bottom widths varying from 10 to 2 ft, about 28 miles of which will be lined with unreinforced-concrete lining and about 30 miles of which will be lined with compacted earth lining. Block 81, near Othello.
Do	Constructing about 6.7 miles of buried pipe drains for Farm Unit 15, block 11; and Farm Units 110, 111, 114, and 117, block 20. Northwest of Mesa.
Emery County, Utah	Constructing the reinforced-concrete Swasey Diversion Dam consisting of an ogee overflow weir about 75 ft long, a canal headworks structure with two 72-ft by 48-in. cast iron slide gates, a sluiceway structure with one 10- by 10-ft radial gate and about 800 ft of compacted earth dikes; and earthwork and structures for about 3.6 miles of 12-ft bottom width open canal, part of which is to be lined with buried asphalt membrane lining. Near Castle Dale.
Fryingpan - Arkansas, Colo.	Constructing field office facilities consisting of a 24- by 132-ft metal office building, a 28- by 52-ft metal laboratory building, a 32- by 60-ft metal drilling operations building, and a 20- by 220-ft metal garage building. Work will also consist of constructing access roads, parking areas, and utilities. Near Ruedi.
MRBP, Minnesota	Additions to the Granite Falls Substation will consist of constructing concrete foundations; furnishing and erecting steel structures; and furnishing and installing one 115- and two 69-kv circuit breakers and associated electrical equipment.
MRBP, Montana	Constructing Yellowtail Afterbay Diversion Dam, an earthfill and concrete structure about 53-ft high and about 1,400-ft long, with a sluiceway and a gated overflow spillway. Work will also include constructing a canal headworks in the right abutment for diversion into the existing Big Horn Canal. Sluiceway will contain three 120- by 96-in. slide gates, the spillway five 30-ft by 13-ft 6-in. radial gates, and the headworks two 120- by 96-in. slide gates. Sluiceway and headworks gates will be automatically operated from a rating section and gaging station in the canal. On the Big Horn River, about 2 miles downstream from Yellowtail Dam and about 40 miles southwest of Hardin.
MRBP, Nebraska	Earthwork and structures for about 40 miles of open laterals with bottom widths varying from 18 to 3 ft, of which about 26 miles will be lined with compacted earth lining. Ainsworth laterals, second section. Near Ainsworth.
Do	Constructing about 10 miles of 20-ft-wide roadway with 4-in. bituminous sand mat surfacing, a 32-ft-span timber bridge, parking areas, and recreation facilities. At Merritt Reservoir, about 25 miles southwest of Valentine.
Do	Constructing Stegall Substation, stage 01, will consist of constructing a concrete masonry service building; constructing foundations; furnishing and erecting steel structures; furnishing and installing three single-phase, 33,333-kva, 230/115-kv autotransformers, two 230-kv, six 115-kv and two 14.4-kv circuit breakers, six single-phase, 5,000-kva shunt reactors, and associated electrical equipment; and grading and fencing the area. Near Gering.
Do	Constructing Deer Station Pumping Plant, an outdoor-type, wet-sump, reinforced-concrete plant, about 20-ft wide and 36-ft long and 17-ft deep. The contractor will furnish and install four vertical turbine, electric-motor-driven pumping units with a total capacity of 27 cfs at 110 ft. North of Grand Island.
MRBP, No. Dakota	Construction Hillsboro Substation, stage 01, will consist of constructing a concrete masonry unit service building; constructing foundations; furnishing and erecting steel structures; installing one 3-phase, 6,000-kva, 115/69/12.4-kv transformer and one 14.4-kv circuit breaker and associated electrical equipment; and grading and fencing the area.
MRBP, So. Dakota	Furnishing and stringing six 1,272 MCM conductors and two steel strand, overhead ground wires for about 146.2 miles of double-circuit, steel tower line except that 2-conductor bundle of 556.5 MCM, ACSR will be used in lieu of single conductor 1,272 MCM, ACSR as follows: For both circuits in about 3.8 miles of line and for one circuit in about 4 miles of line. From Fort Thompson Substation to Sioux Falls Substation.
Do	Constructing the New Underwood Substation will consist of constructing a 64- by 50-ft concrete masonry warehouse and garage and a 75-ft 4-in. by 37-ft 4-in. concrete masonry service building; constructing foundations; furnishing and erecting steel structures; furnishing and installing three single-phase, 100-mva, 230/115-kv transformers, two 230-kv and four 115-kv circuit breakers, and three banks of 16.5-mva reactors, and associated electrical equipment; and grading and fencing the area.

*Subject to change.

(Continued on page 24)

In its assigned function as the Nation's principal natural resource agency, the Department of the Interior bears a special obligation to assure that our expendable resources are conserved, that renewable resources are managed to produce optimum yields, and that all resources contribute their full measure to the progress, prosperity, and security of America, now and in the future.

U.S. Department of the Interior
Bureau of Reclamation

May 1964

Reclamation ERA

RECLAMATION EXPERIMENT GETS A LIFT

Reclamation ERA

MAY 1964

Volume 50, No. 2

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Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C., 20240. Use of funds for printing this publication has been approved by the Director of the Bureau of the Budget, January 31, 1961.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Price 15 cents (single copy). Subscription price: Eight issues (2 years) for $1.00 ($1.50 for foreign mailing).

Foreign Aid in—

"The Land of the Queen of Sheba"

by **CLYDE E. BURDICK,**

Team Leader and Project Engineer, Blue Nile River Investigations Project

THE BUREAU of Reclamation has been called upon to provide technical assistance in water resourses development in many foreign countries, but perhaps assistance in few of the countries offers the unusualness and excitement of the ancient empire of Ethiopia. A team of Reclamation employees recently returned to the United States after completing a 5-year investigation survey of Ethiopia's Blue Nile River Basin.

The program was conducted under an interagency agreement between the Bureau of Reclamation and the Agency for International Development of the Department of State, as a part of the United States foreign aid program to assist underdeveloped nations.

Primarily the program, in this case, was to provide technical assistance to the Imperial Ethiopian Government in inventorying the land and water resources of the great Blue Nile River Basin, to assist them in the development of a Water Resources Department, to train personnel in the technical and administrative fields, and to prepare a report evaluating potential projects and presenting a general plan of development.

It was a challenging assignment, and living and working in the Empire of Ethiopia involved some difficulties.

Ethiopia has an area of about 450,000 square miles and a population of about 20 million people, of which about 90 percent are engaged in a subsistence type of agriculture much the same as their ancestors practiced for thousands of years. Ethiopia is situated in part of the "Horn of Africa," in the eastern corner of the continent bordering the Red Sea. The southernmost tip of Ethiopia is only about 250 miles north of the Equator.

The central area of the country is a vast plateau having an average elevation of about 8,000 feet but with a number of mountains that rise above the plateau to elevations of 12 to 15 thousand feet. Around the perimeter, the terrain drops off to the flat lowlands and tropical desert. The plateau is cut by the Great Rift, the canyons of the Blue Nile, and numberless other valleys and gorges with steep sidewalls often thousands of feet down.

The railroad station at Addis Ababa, capital city of Ethiopia.

It is one of the most spectacularly beautiful areas of the world, but it disguises a harshness that with other factors has isolated Ethiopia from the rest of the world until recent years.

The Government of Ethiopia is a constitutional monarchy. The ruling monarch, His Imperial Majesty Haile Selassie I, Emperor of Ethiopia, King of Kings, Elect of God, and Conquering Lion of Judah, began his reign as Regent in 1916 and ascended to the throne as Emperor on November 2, 1930. Contrary to the belief of many who have not visited the area, the capital city of Addis Ababa, where the Reclamation team was to make its headquarters, has a delightful and healthful climate in spite of its proximity to the Equator. Here on the plateau, the daytime temperatures range from about 60° to 80° F. throughout the year. The nights are cool, and a small fire in the fireplace during the evening was always pleasant.

When Commissioner Floyd E. Dominy arrived in Ethiopia to make an inspection of Reclamation work there, this picture was taken at Bureau headquarters. Left to right are Garton, Ato Teshome, Johnson, Halliday, Curits, Albert, Borgeson, Burdick (the author), Kim, Scott, Austin, Sower, Commissioner Dominy, Ato Mebrahtu, Mabbott, Ato Kefyalew, Bright, Sipinen, Abbott and Ato Mersha.

Wet and Dry Seasons

There are only two recognizable seasons—the dry season and the season of the big rains. During the dry season in February and March, the countryside is brown, and livestock must be driven many miles to water. In the season of the big rains, however, June through September, Ethiopia receives about 80 percent of her approximately 80 inches of annual rainfall, and countryside turns a lush green. Streambeds, dry for months, then carry torrents of water and overflow their banks. Fields become too wet to work, and all roads except those with hard surfaces become impassable to traffic.

The lowlands surrounding the plateau have a similar pattern of rainfall, but the temperatures are much higher and the climate can be considered tropical. Most of the people live on the highlands above 6,000 feet.

Ethiopia is often referred to as "The Land of the Queen of Sheba" or "The Land of the Lion of Judah." Both names are deeply rooted in Ethiopian lore. According to their history, Queen Makeda, one of the early rulers as the Queen of Sheba, was the sovereign of a rich and powerful kingdom including not only the greater part of Ethiopia but also much of present day Yemen across the Red Sea. Legend records that the Queen of Sheba bore Solomon's son, Menelek, who became King Menelek I, thus launching the Ethiopian dynasty known today as the Solomonic line.

Ethiopia is a country shrouded in mystery. But it is believed that the earliest people were of Hamitic origin and that early Semitic immigration influenced the Ethiopian racial characteristics. Amharic is the national language of Ethiopia. However, English is spoken by many countrymen and the Reclamation personnel soon acquired a working knowledge of Amharic. Consequently, they had little difficulty communicating with Ethiopian personnel employed on the investigation.

Named Blue Nile

The Blue Nile—surely not named for the color of its water, but likely, because of the smoky haze that hangs in the canyon—drains about 80,000 square miles or approximately the northwestern one-sixth of the nation. Its length within Ethiopian borders is about 540 miles, and at the Sudanese border it discharges about 40 million acre-feet annually. To help visualize the extent of the Blue Nile Basin, a rough comparison with the Colorado River in the United States follows:

	Blue Nile	*Colorado*
Drainage area____square miles__	80, 000	244, 000
Length ________________miles__	540	1, 400
Discharge at border____acre-feet per year__	40, 000, 000	17, 700, 000
Average flow at border____cubic feet per second__	56, 000	22, 800

The Reclamation team was confronted with many problems common to most basin-wide investigations. However, here they were com-

A Reclamation employee explains drawings to Ethiopians.

Three trained Ethiopians are preparing to make a streamflow measurement.

pounded by lack of experienced help; rough inaccurate maps of the area; and a single road into the interior of the basin which could be traveled only by four-wheel drive vehicles during the dry season. During the big rains transportation was a major problem and the road became impassable to all vehicles. Helicopters were used extensively, but even this modern transportation required a great deal of ground support to keep it moving. Each helicopter with its pilot and two passengers, could fly about 2½ hours or a radius of about 75 miles from a base of operations. Therefore, to cover the interior of the basin it was necessary to move a camp with equipment, aviation gasoline, and other supplies by truck over rough terrain following animal trails or foot paths not developed for vehicle travel.

In some remote areas, the camp and supplies were ferried in by helicopter before flying in the personnel. If flying exceeded 3 or 4 days, the Ethiopian airlines, who provided the helicopter service under contract, would send along a field mechanic to service them. For short flights, the pilot did this himself. The pilots were mostly Frenchmen and the mechanics Germans, each usually speaking only a smattering of English. Occasionally this resulted in amusing and often exasperating experiences.

In one instance, a Bureau engineer flying with a French pilot pointed to a huge pile of sawdust beside a sawmill. The pilot, thinking he wanted to land and mistaking the sawdust for sand, swooped down and landed causing a storm of sawdust. After the natives and the Italian manager, who had run out from all directions to surround the pile of sawdust to watch the copter land, had finally cleared their eyes, ears and hair, the visitors were given a hearty welcome. Although the Italian could speak neither French nor English, a greeting was readily conveyed and a drink of tea enjoyed. For the departure, the spectators stood well back from the impending storm of sawdust.

On another occasion, an 8-foot length of 36-inch corrugated iron pipe was being transported by helicopter to a remote streamgage station site. The rope holding the pipe beneath the helicopter broke, and the local people, assuming they were being bombarded by a foreign enemy, took a few shots at the copter and then "dug in" to defend their territory. Operations were suspended in the area for a few days while the police moved in to assure the people that the "invaders" were friendly. This station was located in a 4,000-foot deep canyon, and all materials and equipment, including a cableway, were flown in, piece by piece, and assembled on the site.

Colorful But Noisy

Construction of each of the 21 major gaging stations presented diverse problems, comic incidents, and occasional serious consequences. One station, accessible only by helicopter or on foot, required a cable of greater weight than could be carried by the helicopter. Solution? A native porter every 6 feet of its 630-foot length carried it about 25 miles down into the deep canyon. This colorful but noisy human chain tramped in unison as a precision drill team, over rocks, around trees, and across gullies to complete the trek in less than 2 days.

After the gaging stations were constructed, the operation and collection of records presented a new problem. Construction work had been done, mainly, during the dry season, but now it was important to operate stations and collect records during the rainy season when most of the runoff

This semipermanent camp scene near the Sudan border shows a portion of the parked helicopter.

occurs. At first, when the stations were few and Ethiopian personnel lacked training, an engineer with a group of Ethiopian trainees operated the station and made daily measurements. As more stations were constructed and the Ethiopian personnel trained, the operations were gradually turned over to the home forces and the Bureau men continued in an advisory capacity.

Helicopter transportation, with the hazards of seasonal heavy rain and low hanging clouds, was often cause for serious concern. Emergency and crash landings occurred quite frequently, however, only one fatal crash occurred. It resulted in the death of the British pilot and two Bureau soil scientists. Other crashes seriously damaging the aircraft, or injuring the passengers were few. Occasionally, a team would be forced to spend a few days in "the bush" on short rations waiting for rescue after failure of the copter's motor, battery, or for some other disabling cause.

For 5 days, two hydrologists were stranded at the Shogali gaging station with only a day's rations. Their helicopter battery had failed, preventing a radio appeal for help. Search planes located them on the fifth day and returned them to headquarters, hungry but otherwise in good condition.

Wild game is usually plentiful and the engineer with a good eye and a high powered rifle generally supplied the field camp with meat. Some of the Bureau field personnel also were camera fans who collected pictures of the country, people, and wildlife.

A few popular photogenic subjects are the ancient castles of Gondar, the stone churches of Lalibela carved in solid rock, Tis Isat Falls on the Blue Nile, and the very old churches of Axum.

Home Life

For the families and those members of the team whose duties did not require field travel, Addis Ababa was not an unpleasant place to live. Theaters, churches, schools, and several hospitals are located there, and the Imperial Golf Club provided adequate recreation.

A trip to Asmara, Eritrea, once during a tour of duty, was almost a must. This 620-mile drive over a scenic, mountainous, gravel surfaced highway was usually a 3-day trip. Several cars usually formed a caravan. Upon arrival in Asmara, the snack bar at the U.S. Army Kagnew Station was an early stop for hamburgers, malts, and ice cream, which were unavailable in Addis Ababa.

Fieldwork for the Blue Nile investigation was completed in late 1963 and the team returned to the United States to complete the preparation of a report. It is necessary to outline plans for the development of the projects which are planned to irrigate about one million acres of land and provide about five million kilowatts of hydroelectric power capacity.

Ethiopia is one of the most underdeveloped countries in the world, but has vast land and water resources. The Imperial Government is making the effort to develop them and to improve its national economy and the standard of living for its people. Their Reclamation program includes obtaining expert guidance which we believe will assist that country and lead to the utilization of valuable resources of the Blue Nile for the benefit of the Ethiopian people. # # #

Reclamation Experiment *gets a* LIFT

One of the most dramatic phases of an experiment in finding new designs and construction methods for economical and efficient power transmission lines was staged in the northeastern Arizona desert. Here, in a land where history is kept alive by the remains of 1,100-year-old cliff dwellings, the air of January mornings in 1964 were stirred by the rotors of a hovering helicopter erecting new transmission towers.

In near-freezing temperatures on January 27–28, the Bureau for the first time raised into position the sections of transmission towers slung from a "whirlybird." They were among 28 special test towers constructed in an 8-mile section in the 182-mile-long Glen Canyon-Shiprock Transmission Line scheduled soon to carry 230-kilovolt power from giant Glen Canyon Dam powerplant.

Data from the 8-mile line will aid in determining which new types of high-voltage towers can economically be developed, fabricated, and erected. Particular interest has been centered in transporting and tower erecting by helicopter.

Construction Helicopters, Inc., contractor for the experiment, flew a Model 204B Bell helicopter. The ground crew wore dust goggles for safety and replaced their "hard hats" with more snug fitting football helmets which could not be blown off in copter wind.

The contractor erected two, three-legged aluminum towers in three lifts each by helicopter. Also, two, four-legged, aluminum towers were erected by the aircraft except for the bottom sections which were raised by crane, shown standing by in some of the accompanying photos.

For raising the upper sections of the tower, a carefully measured steel cable sling was fastened by a cargo hook, while the helicopter hovered over a preassembled section. The copter then raised the new section vertically and brought it into position. Alignment of the section into exact position was accomplished by two groundmen holding long tag lines attached at the other end to suspend tower sections as shown in accompanying photos.

When properly aligned, the tower crews at the corners bolted the section into place. Tower men then moved away to avoid the falling sling which was released from the aircraft by the pilot. Instructions between the pilot and ground crew were aided by using radio and hand signals.

Accurate time records were kept on the placement of each section. Seven to nine minutes were needed for average placement, exclusive of final tightening of bolts or guys.

Following completion of the towers and the stringing of conductors and ground wires will be the installation of strain gages and other special equipment to record structural performance.

Performance of the test section is expected to provide valuable data. Newly designed transmission towers which will be economical to build and erect are anticipated for a wide variety of climatic, topographic, and foundation conditions. And probably some, like these experimental towers, will be given a "lift from the sky."

In the meantime, the Bureau has learned that construction by helicopter can be effectively and safely carried out, and crews have learned important details of a new construction procedure.

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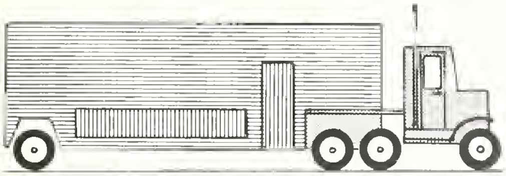
The cover photos and the others accompanying this article are by A. E. Turner.

RAISED BY CRANE—Three linemen guide the leg of an aluminum H-frame structure onto a foundation ball. It is part of the test section of towers described in the story, but the leg was raised by the crane shown in other photos.

A FINISHING TOUCH ON A CONVENTIONAL TOWER—A lineman perches on a high beam and attaches an insulator assembly. This conventional structure was raised by the crane in another part of the transmission line spanning the 182 miles from Glen Canyon Powerplant in Arizona, to Shiprock, N. Mex.

Testing Away From Home . . .



RESEARCH WITH A ROADMAP

Reclamation's Research Center at Denver has put much of its electrical test program on wheels to make on-the-spot studies of Bureau power facilities throughout the Western United States. Characteristics of Reclamation power systems and the adequacy of the ever increasing variety of electrical apparatus and equipment will be examined in a new mobile laboratory, recently outfitted to do a long needed and hoped for job.

Although many investigations can be performed in a regular laboratory, much important information can be obtained only from the power system itself. The performance of certain electrical apparatus is influenced as much by the far flung power system to which it is connected as by its internal design. Conclusive performance tests of such apparatus must be made while it is energized by the system it is to serve.

Another important need is to verify the coordination or teamwork performance of the many different devices which must execute their functions in a fraction of a second. The requirement calls for laboratory precision and versatility but at many different field locations in turn.

These are the kinds of jobs that will challenge the traveling laboratory. The trailer housing this new custom designed mobile laboratory is 11½ feet high, 8 feet wide, 32 feet long, and weighs 16,600 pounds, including equipment. At this size and weight, the laboratory can be transported over Western State highways without need for special permit.

The laboratory is more completely equipped than any other now in use. The principal recording instrument is an oscillograph, which provides a permanent record of both static and dynamic electric phenomena. The model used is the latest design magnetic oscillograph, capable of "direct write" records for instant viewing.

The mobile laboratory is equipped with many communication facilities. These include apparatus for extension from conventional dial telephone system, facilities for extension from handcrank ringer systems, connection to powerline carrier telephone and a complete independent local telephone system for communication during setup and test.

The unit is also equipped with a radio, tunable to each of the project radio systems, as well as a public address system to assist in conducting tests.

A self-contained engine-driven power supply provides complete power independence. This same generating unit is capable of operating the heating and air-conditioning equipment.

Thus equipped, the laboratory will permit vital performance tests and data collection for a wide

Side compartment is handy for operators to use reels, instruments and other contents.

Inside equipment includes console for control of power apparatus; also public address system, radio, telephone and auxiliary power set.

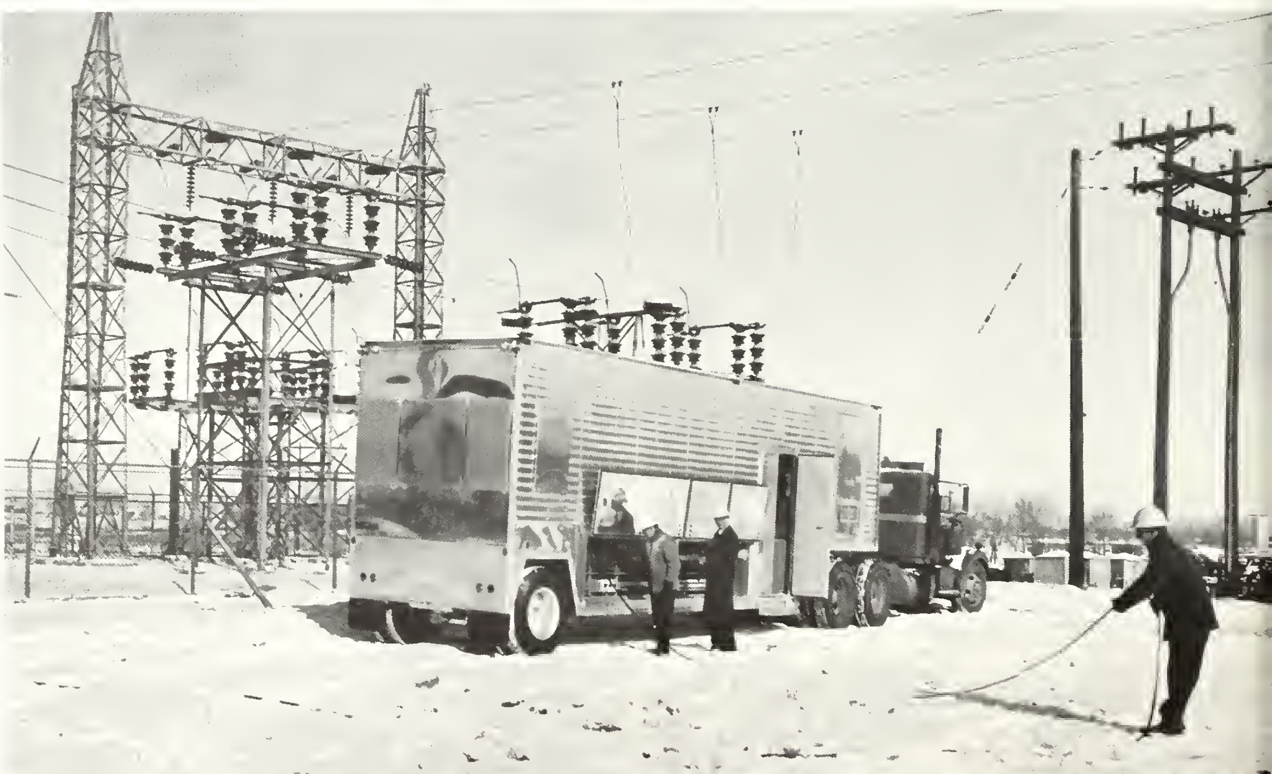
range of power system requirements including verification of performance of new equipment, identification of deficiencies of old equipment, and the determination of system requirements which future apparatus must meet.

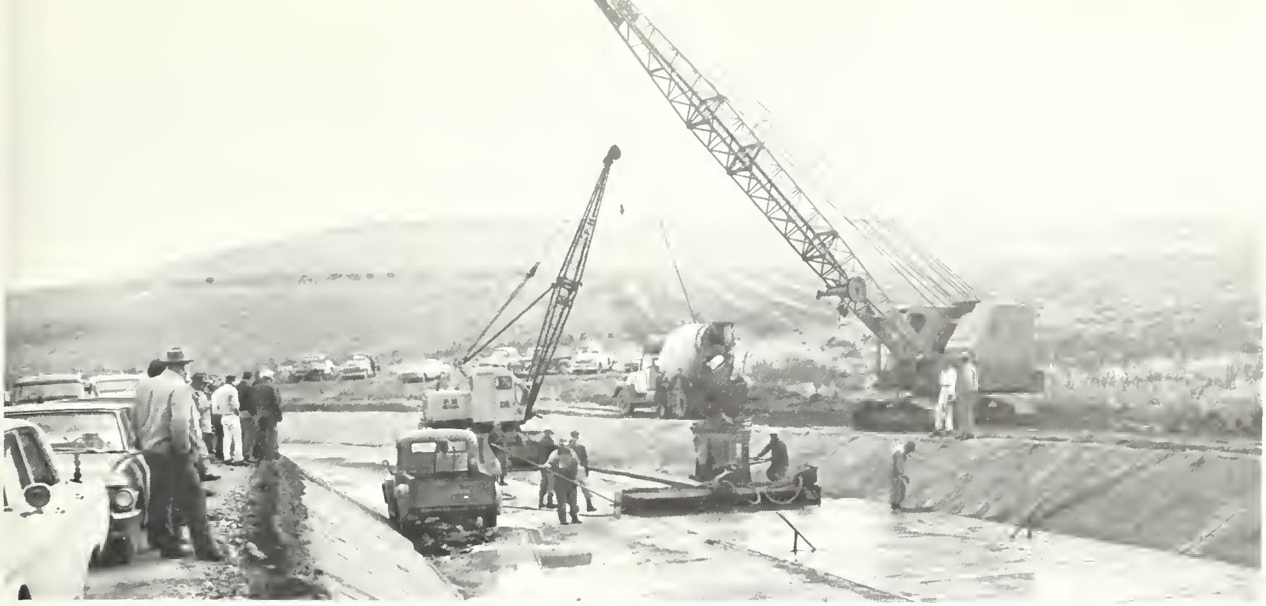
Testing of the new features being employed on the gigantic Colorado River Storage Project is among the more important and more urgent jobs it will be doing.

For much of its work, the mobile laboratory will be transported with most of its instrumentation interconnections already made up, saving much time on the site. A compartment of cables on reels for external connections expedites setup and power-driven-rewind speeds preparation for the next move.

Manned with Bureau specialists and a driver, and equipped with portable power instruments for a variety of field power jobs, relay tests and adjustments, meter tests and a complete set of versatile electronic instruments, the mobile laboratory helps the Bureau perform valuable research "with a roadmap." # # #

Cables are unreeled and connected quickly after the unit is brought to a power substation. The laboratory is 32 feet long and weighs 16,600 pounds.





A STITCH IN TIME . . .

by **S. T. LARSEN,** CHIEF,
Maintenance Engineering Branch,
Denver, Colo.

The Bureau of Reclamation, since its establishment in 1902, has designed and directed the construction of over $4.3 billion worth of facilities to serve the citizens of 19 Western States, including Alaska and Hawaii.

Projects of the Bureau range in size from the Intake Project, canal and pumping plant costing $94,000, to the Missouri River Basin Project, covering 10 States, which ultimately will cost $3.5 billion. Projects authorized by Congress number 136 and will reflect a total cost of more than $9.1 billion when completed.

Regardless of the care in design, construction, purchase of materials, or other precautions in the planning and building of a project, its facilities will deteriorate if they do not have systematic and continuing maintenance.

Now, the Bureau is more than 61 years old and many of its early structures are nearing, or have passed, the half-century mark—structures that would require many times their original construction cost to replace. A recent tabulation of Bureau structures listed 171 storage dams, 96 diversion dams, 44 powerplant structures, 449 pumping plants, 6,040 miles of main supply canals, and other special features, such as major desilting works, aqueducts, siphons and tunnels.

Fifteen years ago, the Bureau recognized the need for preserving these features. It broadened its efforts of increasing maintenance with initiation of the Review of Maintenance Program. The program provides for the regular examination of all irrigation facilities with emphasis on discovering the need for repairs before deterioration advances to the point of being costly to correct. Its purpose is to encourage the highest practical level of maintenance and recommend, and assist in, structure and equipment improvements.

Safeguard Continues

This effort to provide a "stitch in time" for the facilities built by the Bureau does not stop when they are turned over to the water users for operation and maintenance. In continuing to safeguard the public investment, regional directors of the Bureau's seven regions are responsible for proper maintenance of Reclamation projects by these operating officials. There is the need for cooperation to provide maximum benefits as well as the periodic examination while costs for repair or replacement would be minimal.

The regional staff examines the project works biennially and representatives of the Chief Engineer's Office of Denver, Colo., examine principal structures and facilities at least once every 6 years.

The review team watches while a 4-inch thickness of new concrete is being placed over a deteriorated concrete lining in Deer Flat Low Line Canal near the Snake River, Idaho.

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A newly constructed wasteway box on a lateral in the Boise Project area also is inspected.

This program also provides opportunities to maintain contracts and to learn of operating problems and the condition of projects.

A typical review of a facility is made by representatives of the several groups involved—examining engineers from the Chief Engineer's Office, engineers from the Bureau's regional office and project office, representatives of the irrigation district, project board of control, and possibly others as well.

Ideas of operation and maintenance procedures are exchanged and data are gathered on performance leading to improvements of designs.

Good cooperation has been achieved among these representatives. They have found that the periodic visits by Bureau personnel afford excellent opportunities to discuss O&M problems with those who have access to the extensive Bureau research and engineering facilities at the Denver office.

With the Denver staff conducting examinations of the hundreds of major facilities, the examinations by the region are proving to be important supplements to Denver's findings and recommendations.

The review group thoroughly examines structures and facilities and recommends maintenance work that is considered advisable. In most instances, agreement by all parties on the need for repairs and exchange of ideas on the methods of repair are possible during the field examination.

Three Categories

Decisions on repairs are categorized and recorded according to urgency. Category (1) is for the safety or adequate functioning of the facilities, and is considered an emergency need requiring immediate action. In Category (2) a wide range of important actions are indicated to prevent or reduce further damage or guard against eventual operational failure. Matters of lesser importance are identified in Category (3) suggestions which the review team believe to be sound and beneficial to the facility, with the work to be done as funds and personnel permit.

A complete record of all findings, observations, and recommendations is maintained. The Chief Engineer periodically calls on the regional offices for reports on the status of uncompleted recommendations. A detailed report also is prepared annually by the Chief Engineer for the Commissioner's office in Washington, D.C.

Upon completion of scheduled examinations, meetings are held in the regional office to discuss findings and recommendations. This includes both the broad aspects of maintenance problems, as well as specific problems.

These findings are of benefit to every group represented. The success or failure of materials or design is considered and this has a strong influence on future work. Through continuing research, the latest devices and materials, in turn, are made available to the project. Regular examinations also provide useful information for budgeting of

(*Continued on page 38*)

The review team is inspecting the newly repaired concrete bottom of Mora Canal on the Boise Project.

ANNUAL WORKSHOP PRACTICAL FOR IRRIGATORS

Practical solutions to operating problems were presented at the third annual Irrigation Operators' Workshop, held by the Bureau of Reclamation during November 1963, at Denver, Colo. In this, the largest Bureau workshop held, 117 persons representing all 17 Western Reclamation States, 6 universities and 4 foreign countries, attended.

Specialists conducted courses, presenting information on techniques and practices from a variety of fields for the benefit of project personnel who are directly responsible for the technical details of operating and maintaining irrigation systems. General open discussion was a part of each session.

Each person attended 10 basic courses considered to be fundamental to all irrigation systems. Additional optional courses were offered to cover special interests. Copies of the lecture notes for each course are available from Chief Engineer, Attention 841, Denver Federal Center, Denver, Colo., 80225.

Concrete Practices—The standard equipment on a project most often is adequate to properly construct, maintain and repair operating structures if reasonable care is exercised.

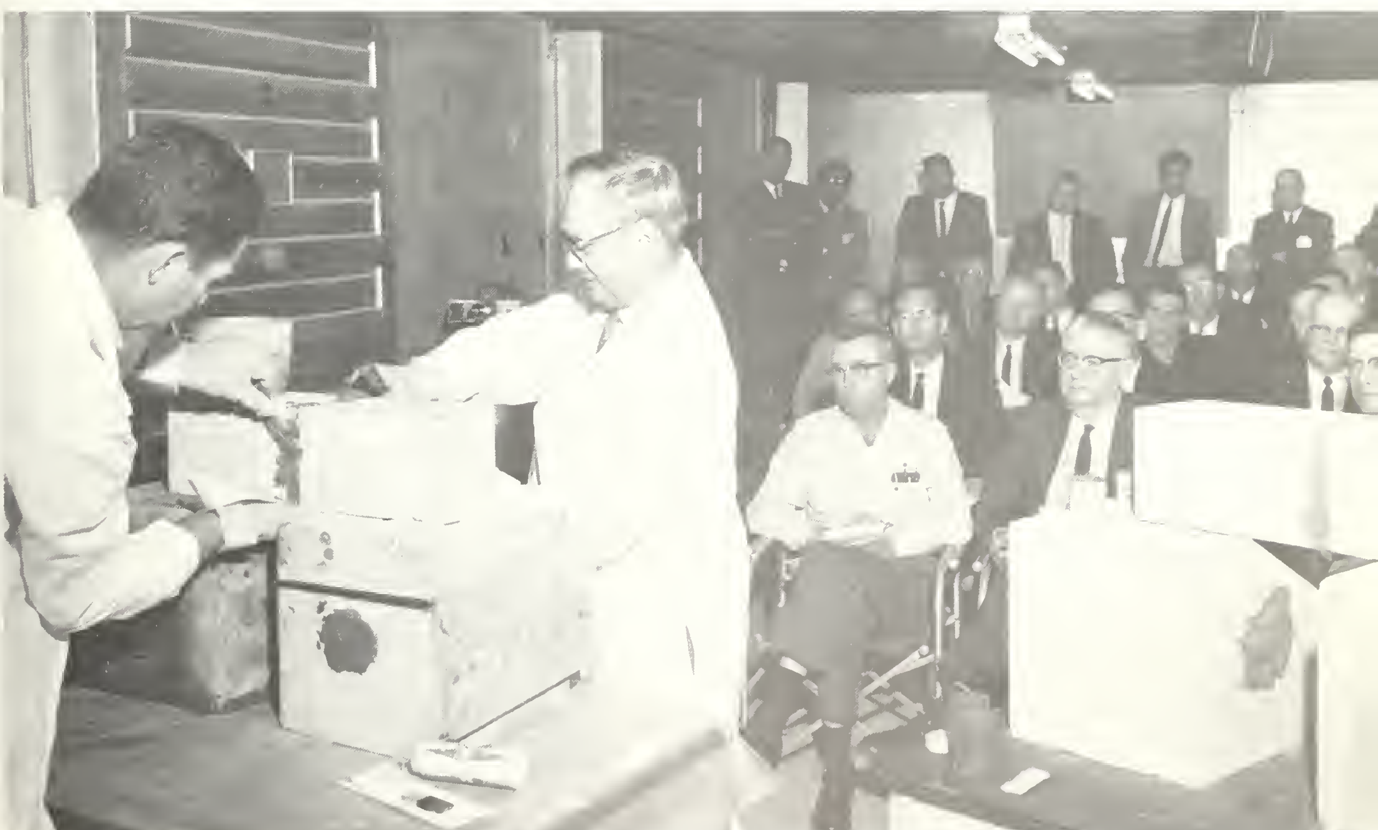
The proper cement and well graded aggregate (sand and gravel) should be used. When using ready-mixed concrete, this material should be obtained from a supplier who is well equipped to control the quality of his product.

Certain repairs of concrete can be done successfully by use of epoxies and low-pressure grouting. Preparation for repair, curing, and care of repairs, and the general maintenance of canal structures are important considerations.

(Presented by G. B. Wallace, A. B. Crosby, and L. J. Mitchell of the Concrete and Structural Branch, Division of Research.)

Equipment Management—Equipment on a project is selected according to the work to be done

The study of concrete practices included a demonstration of the use of epoxies.



Field techniques for testing the workability and consistency of concrete are demonstrated.

and the versatility and adaptability of the machines.

Owning, as opposed to renting, sufficient equipment to perform all required work is an important factor to consider. The size of the project and the type of system are among the principal considerations to be weighed in evaluating one piece of equipment against another, prior to purchasing.

It is useful and important to keep cost records for individual pieces of equipment so that costs of operation and ownership are always available.

(Presented by Richard H. Kennedy, Chief of Irrigation Operations, on the Bureau's East Bench Unit at Dillon, Mont.)

Operation and Maintenance Safety—Many irrigation projects have unsafe practices resulting in high incidence of lost-time accidents. A safety program is a good investment because it reduces workmens' compensation premiums, lost time, and enhances employee welfare. The average project, large or small, can take positive steps toward elimination of occupational and public injuries.

(Presented by E. R. Wheeler, Safety Director for the Salt River Project, Arizona, and K. E. Surratt of the same organization.)

Pipe Systems Maintenance—Pipe leaks are the most common maintenance problem of water districts, and there are various successful methods of repair.

Poor maintenance practices on pipelines is not good policy.

(Presented by H. E. Van Every, Head of the Water Maintenance Section for the Bureau's regional office in Sacramento, Calif.)

Associate Chief Engineer E. V. Lindseth awards certificates to participants upon completion of the 1963 workshop.

Project Management—It was urged that methods and procedures be developed for long-range maintenance programs. Routine activities as well as the unusual jobs should be planned and budgeted for, and large expenditures should be anticipated and provided for.

The manager and board should function together as a team, and the principles of maintaining favorable relations between management, employees, and water users should be observed.

(Presented by Robert M. Fagerberg of the Shoshone Irrigation District at Powell, Wyo.)

Protection of surfaces—Samples of various coatings were subjected to tests and exhibited. The selection of the proper coating for a given surface is emphasized.

Adequate cleanup of surfaces prior to coating application, methods of cleanup, preparation of coating application and curing are important to the protection of surfaces.

(Presented by P. W. Lewis and J. L. Kiewit of the Bureau's Coatings Sealers and Plastics Section.)

Rehabilitation of Distribution Systems—Many irrigation districts, particularly older ones, are replacing open chutes, troublesome reaches of laterals and leaky channels with pipe. This is being done in many cases as part of a rehabilitation and betterment program which often includes the replacement of other structures in the system.

Replacing canal and lateral structures with modern facilities involves design considerations. There are also other means of improving the operation of an open or closed system. Adequate maintenance is important.

(Presented by B. A. Prichard of the Operations Engineering Branch (Irrigation) and M. E. Day of the Canals Design Branch.)

Canal Lining and Soil Sealants—The more common types of linings are slip-form concrete, earth, and asphalt and plastic membranes.

The methods of installation and relative costs of each type, as well as the advantages and disadvantages of each, should be weighed for their merits. Experiments are in progress on soil sealant materials to reduce seepage from channels and ponds.

(Presented by R. J. Willson of the Maintenance Engineering Branch—Irrigation.)

Water Management—Water may be measured effectively even under adverse conditions if the basic principles are understood and good practices exercised. One new development in water measurement is the use of radioisotopes.

The control and distribution of irrigation water include establishing good rules and regulations by the board of control, a good system of scheduling water, and the necessary controls to accomplish uniform service to all users with a minimum of waste.

Water records must be maintained to effectively manage the water supply under any delivery system.

(Presented by A. J. Peterka and J. C. Schuster of the Special Investigations Section and P. L. House, Manager, Owyhee Project North Board of Control.)

Weed Control—"During the past 20 years, we have seen the science of weed control advance more than in the previous 100 centuries."

Assistance can be secured on weed control problems, a good grass seeding program, control equipment, and in obtaining specifications and requirements used in procurement of herbicides. The identification of the weed problem, selection of the method of control, application, and equipment are important in both land and aquatic weeds.

(Presented by Dean M. Schachterle of Region 7 in Denver.)

Cathodic Protection—The method of preventing corrosion by applying a direct electrical current to submerged or buried steel requires the application of sound engineering principles.

(Presented by L. O. Timblin, Jr., and T. E. Backstrom of the Chemical Engineering Branch.)

Drainage—"Today drainage is out of the guessing and speculating stage where it had so long been."

Although sound judgment is still essential to a good job, the technical tools are now available to make drainage a precise and economically feasible engineering undertaking.

The basic principles involve symptoms, causes, and solutions to drainage problems. Symptoms of the problems include rising ground water, waterlogging, salinization, soil deterioration, and crop response.

(Presented by Charles N. Maierhofer, Chief of the Division of Drainage and Groundwater Engineering.)

Earth Construction Practices—In judging the adequacy of foundations, the irrigation operator must consider bearing capacity, stability, settlement, expansion, deterioration, and permeability.

Information is available in the Bureau's Earth Manual on the construction of roads, embankments, linings, blankets and filters placement of backfill, blending of materials from borrow pits, the methods of determining the quality of the work accomplished, soil properties and methods for identifying and selecting soils for structural purposes.

(Presented by H. J. Gibbs and A. A. Wagner of the Soils Engineering Branch.)

Electrical Maintenance—Proper care, stocking of spare parts and periodic inspections are preventive maintenance practices which can minimize costs of electrical maintenance.

(Presented by John M. Eyer, Chief of the Bureau's Replacement Engineering Branch—Irrigation.)

Electronic Control of Irrigation Systems—Remote and automatic control facilities have been installed on many irrigation projects to control the operation of pumping plants, bifurcation works, diversion works, canal checks and other facilities.

Reduced operating costs, through labor savings, and efficient operation, have justified these installations to irrigation projects.

(Presented by P. R. Hanson of the Bureau's Maintenance Engineering Branch—Power.)

Pump Maintenance—The characteristics of each type of pump and problems or troubles commonly encountered were discussed as were the stocking of spare parts, need for periodic inspection and repair or replacement or parts.

(Presented by W. W. Beck of the Hydraulic Machinery Branch.)

Water Conservation—The conservation of our water resources is recognized as a national problem and one in which the Bureau of Reclamation is actively interested.

Studies on the control of evaporation from reservoirs, weather modification, and desalination of water are undeway.

(Presented by Walter W. Garstka, Chief of the Bureau's Water Conservation Branch.)

Labor and Human Relations—"Labor Relations on Irrigation Projects," was the subject of a talk by H. Shipley Associate General Manager of the Salt River Project, Phoenix, Ariz., at the first of two evening meetings.

Professor Otis Lipstreau, of the University of Colorado, addressed the second evening meeting on the subject, "What is a Person?" Basic human relations considerations should be observed by irrigation managers in dealing with boards of directors, water users, employees, and the general public, Professor Lipstreau said. (Copies of these two speeches are not available.)

Responses to the workshops has been enthusiastic and the Bureau's Division of Irrigation Operations plans to continue them annually. # # #

A Stitch in Time

(Continued from page 34)

funds for maintenance, and for spacing maintenance projects to avoid overloads of work.

Over the years, the program has grown. This growth will continue as the age of the projects increases, and as additional projects are transferred from the construction stage to operation and maintenance by the Bureau or the water users.

Early in the examination program it was observed that little maintenance had been done on some of the older structures. This presented the challenge of bringing the condition of these facilities up to an acceptable level.

In other cases, it was found that older dams had no written maintenance and operating instructions. Without these instructions, in some instances, systematic maintenance of mechanical equipment had been lacking. Among other things, gear cases had not been drained, oil levels had not been replenished, and bearings had not been greased.

Since instructions are now provided for the operation and maintenance of Bureau equipment, operators can test and use it to its full capability. As operators become familiar with the instructions, the possibility of damage or malfunction, should an emergency occur, is decreased.

The effect of the Review of Maintenance Program on these situations has been apparent almost immediately. Gradually, as the years passed, the general condition of the facilities has been upgraded to the point now that the cost and number of repairs recommended for each facility are expected to diminish; demonstrating that "a stitch in time saves nine." # # #

Reclamation Milestones . . .

The facing operation on Merritt Dam, principal feature of the Ainsworth Unit of the Missouri River Basin Project, is shown in the picture on this page. A black asphalt curing compound has been placed over the soil cement coating, a tough new Bureau development now used on some earthfill dams and other reclamation structures. A few ramps of ordinary soil extend up the side of the newly faced dam for use by dump trucks hauling the upstream facing material to placing areas from the road below.

If it were not for the successful tests of soil cement, this earthfill dam, completed early this year, might not have been built, or might have been built with a more costly protective facing.

A number of visitors with special interests in the operation came to the site during construction to observe the facing work.

A more complete article on this process entitled, "Soil Cement Protection Pays," is in the November 1963 issue of the *Reclamation Era*.

Utilizing high-speed instrumentation and advanced techniques of stress analyses, Bureau engineers are able to make rapid evaluations of stresses in Flaming Gorge Dam, a 502-foot high structure on the Colorado River Storage Project in northern Utah.

During placement of the 970,000-cubic yards of mass concrete in Flaming Gorge Dam, more than 1,100 stress and strain measuring instruments were embedded in the concrete. Technicians read the instruments periodically and forwarded the data to the Bureau's high-speed electronic data processing and plotting equipment in Denver, Colo., where results can be computed in the relatively short period of a few weeks.

Computation results are valuable to Bureau stress analysts and designers in evaluating the structural behavior of the dam during cycles of filling with water, drawdown (run-off water), temperature change, droughts and floods.

Although the behavior of concrete Bureau structures has been under continuous study for the past six decades, instrumentation has made it possible for the first time for the Bureau also to keep abreast of the structural behavior of a dam starting immediately with concrete placement through the various periods of reservoir filling and drawdown.

At previously constructed concrete dams, some 150,000 readings from stress and strain measuring instruments embedded in each dam were required to be reduced annually by manual computation methods. As a result, knowledge of the conditions within the dam was impossible to obtain until months, or even years after readings were made. # # #

River Sport

Photo by D. J. Weir.

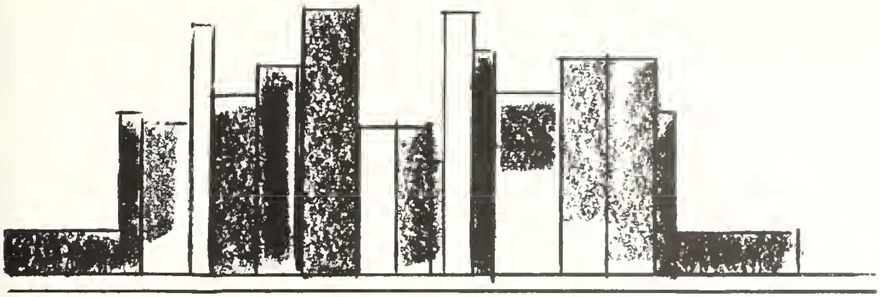
Tubing down Boise River is extremely popular with people of all ages in Boise Valley. On Sunday afternoons, one may see scores of groups such as those shown in the picture on this page, floating on inner tubes or air mattresses. They begin their descent from a point just below Diversion Dam and float to the recently completed Ann Morrison Park. This sport continues through the summer because of the regulated flow of water for irrigation. A recent issue of *Sports Illustrated* helped bring this activity to national attention. # # #

GLEN CANYON UNIT WINS TOP ENGINEERING AWARD

The Bureau's Glen Canyon Bridge, Dam and Powerplant on the Colorado River Storage Project was named winner in the national competition for the "Outstanding Engineering Achievement Award—1964." Selection of the winner from a group of eight nominees was made by seven editors of engineering magazines. The award is given annually by the American Society of Civil Engineers to "the engineering project that demonstrates the greatest engineering skills and represents the greatest contribution to civil engineering and mankind."

The ASCE announcement stated, ". . . the Glen Canyon Project is one of the largest construction projects ever undertaken in the United States. Rising 710 feet, the dam is only 16 feet less than Hoover Dam in height, but exceeds it in concrete volume. Glen Canyon Bridge, which is adjacent to the dam, is the world's highest single span steel arch. The dramatic project is destined to profoundly change an almost uninhabited arid wasteland."

An award made in 1960 named Glen Canyon Bridge as the most beautiful bridge among those with spans of 400 feet or more built in 1959. Certificates of the award, one to the Bureau and one to designer Robert Sailer, were presented by the American Institute of Steel Construction, sponsor of the Aesthetic Prize Bridge competition. # # #



BOOKSHELF for water users

Revised Earth Manual Published

A revised first edition of the Bureau's *Earth Manual* has been published. This 783-page edition has incorporated several new and improved test methods including alternate tests for soil consistency and relative density of cohesionless soils. The manual provides current technical information on the field and laboratory investigations and construction control of soils used as foundations and materials for dams, canals, and many other types of structures built for Reclamation projects. Cost is $3.75.

Research Report is Announced

Research—Engineering Methods and Materials, the first of a new series of Bureau research report publications, is available. The 137-page booklet contains pictures and information on 15 Bureau research efforts and an appendix. It describes research in concrete, soil mechanics, hydraulics, chemistry, physics, petrography and electric power. Copies are available for 50 cents.

Monograph No. 25 is Revised

Engineering Monograph No. 25 entitled, *Hydraulic Design of Stilling Basins and Energy Dissipators*, a water resources technical publication, has been revised. It contains 217 pages and a bibliography, and was prepared by A. J. Peterka, of the Division of Research of the Office of Chief Engineer, Denver, Colo. Cost is $1.75.

The monograph generalizes the design of stilling basins, energy dissipators of several kinds and associated appurtenances. General design rules are presented so that the necessary dimensions for a particular structure may be easily and quickly determined, and the selected values checked by others without the need for exceptional judgment or extensive previous experience. It contains essentially the information contained in several of the Bureau's Hydraulic Laboratory Reports prepared by Mr. Peterka, J. N. Bradley, G. L. Beichley and T. J. Rhone, dated from 1955 to 1961.

New Concrete Manual To Be in Spanish and Portuguese

The seventh edition of the Bureau's *Concrete Manual*, published in late 1963, will be translated into both Spanish and Portuguese. The desirability of translating the manual into both of these languages is to give it the widest possible use on construction projects out of this country financed by loans or grants from the United States. Cost of the English version is $3.25.

Copies of the above publications may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402, and the Chief Engineer, Bureau of Reclamation, Attention: Code 841, Denver Federal Center, Denver, Colo., 80225.

New Guide for All Bureau Authors

As part of the Bureau's efforts to keep its engineers, scientists, and management personnel aware of worldwide advances in the technology of water resources development, a new publication, *Thesaurus of Descriptors*, has been approved for use in the Bureau.

Because of their natural familiarity with their own writings, all Bureau authors of any technical reclamation information are now requested to include with their work an informative abstract of about 200 words in length and a keyword index using the *Thesaurus of Descriptors* as a guide. The new system provides assurance that an author's work will not be buried or lost and that

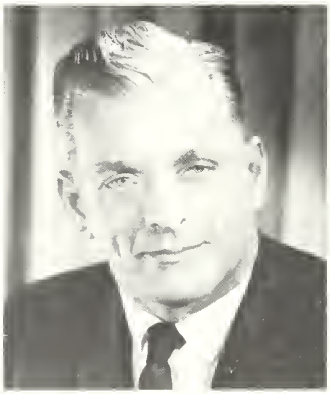
wider use and recognition can be made of his information. For reference to official authorization, see Commissioner's Memorandum No. 162, December 1963.

Film Depicts Development of Missouri River Basin

"Miracle of the Missouri," a new 28-minute film produced by the Bureau, portrays the development of the Missouri River and its tributaries from pioneer days to the present.

Three premieres of the 16-mm, sound-and-color film were held. Congressional delegations of the 10 States comprising the river basin viewed the production at a showing in Washington, D.C. It was shown at a South Dakota Conservancy District meeting in Aberdeen, S. Dak., in conjunction with an address by Kenneth Holum, Assistant Secretary of the Interior for Water and Power Development. And it was shown at the Mississippi Valley Association's annual meeting in New Orleans, at which Commissioner of Reclamation Floyd E. Dominy gave a speech.

JOHNSON NAMED PLANNING OFFICER OF NEW MRB OFFICE; ALDRICH TO DIRECT REGION 6



Bruce Johnson, who has been Regional Director of Region 6 since 1960, on March 27 was appointed Planning Officer of Reclamation's new Missouri River Basin Planning Office, and **Harold E. Aldrich** was appointed new Director of Region 6.

In addition to other duties for the Bureau and the Department, the new office has substantial responsibilities for the comprehensive, long-range planning for the MRB in collaboration with the States and other Federal agencies comprising the MRB Comprehensive Planning Subcommittee. Development of projected water resources studies for the area requires increased Interior effort in concert with other Subcommittee members from the States, the Corps of Engineers, the Department of Health, Education and Welfare, and the Soil Conservation Service. Mr. Johnson will exercise Basin-wide responsibilities in the power program, particularly as Reclamation's representative on the Missouri Basin System's Group. He will coordinate overall planning for future development of the Missouri River Basin with the Reclamation offices in Billings, Mont., and Denver, Colo.

The MRB Planning Officer with headquarters at Omaha, Nebr., will function as Department and Bureau Representative before the public, interagency groups and other organizations including governments of the States involved. As departmental representative he will report to the Office of the Secretary through Harrell F. Mosbaugh, the Department's Regional Coordinator at Billings. Mr. Johnson has had over 23 years' Federal service, starting in 1940 as an engineer with Reclamation. He is a native of Grand Forks, N.Dak., and graduated in civil engineering from the University of North Dakota in 1934, and also received an honorary degree as professional engineer in 1949 from the university.

Regional Supervisor of Irrigation in Region 5 at Amarillo, Tex., since 1960, Mr. Aldrich has been with the Bureau 25 years, and was Manager of the Upper Missouri River District Office in Great Falls, Mont., before going to Amarillo. He is a native of Decatur, Nebr., was awarded a BS degree in engineering from the University of Nebraska in 1935 and is a registered professional engineer in the State of Montana. Before coming into the Bureau 25 years ago, he had two brief periods of service with the U.S. Army Corps of Engineers and the State of Nebraska. # # #

Judge Sturrock Receives Conservation Award

Judge J. E. Sturrock, left, and Secretary of the Interior Stewart L. Udall.

In recognition of his tireless work for the past three decades in furthering water resource developments and conservation on both State and national scopes, Judge J. E. Sturrock of Austin, Tex., was presented the *Conservation Service Award* of the Department of the Interior at ceremonies held on February 19. Secretary of the Interior Stewart L. Udall made the presentation at the annual Washington meeting of the National Reclamation Association Board of Directors.

Judge Sturrock played a major part in developing a unified water plan for the State of Texas, one segment of which was the Texas Basin Project. While working on the solution of State water problems, his role was significant in coordinating with national problems.

At the 1962 annual meeting of the National Rivers and Harbors Congress, Judge Sturrock was awarded the *Willard J. Breidenthal Medal* sponsored by that organization, described in the November 1962 issue of the *Reclamation Era.*

★ ★ ★

Conservation Award Presented to Colorado Man

Secretary of the Interior, left, awarding certificate to Judge Hughes.

Judge Dan H. Hughes of Montrose, Colo., was presented the Department of the Interior *Conservation Service Award* by Secretary of the Interior Stewart L. Udall on March 16 in Washington, D.C. Judge Hughes was commended for his devoted efforts, strong support, and active participation over the years in bringing development to the water resources in the Upper Colorado River Basin.

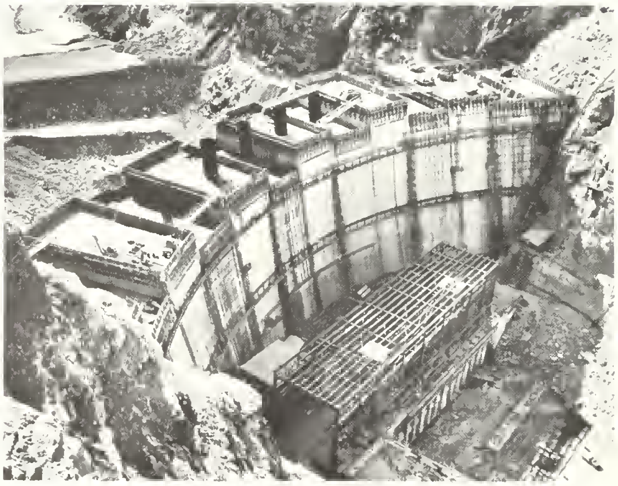
His citation stated: "As the result of your efforts we have such projects as the Uncompahgre, the Colorado-Big Thompson, the Colorado River Storage and Participating Projects, and the Fryingpan-Arkansas. Your influence as a member of the Bureau of Land Management local, State, and national advisory boards, and particularly as Chairman of the National Advisory Board Council has been (of key importance) in the development of our overall land management policies and programs."

★ ★ ★

Region 6 in Pictures . . .

(This region includes North Dakota, South Dakota, most of Montana, and part of Idaho.)

These two young fishermen are trying their luck in the Jamestown Reservoir on Garrison Diversion Unit in North Dakota. Jamestown Dam provides urgent flood protection to the city of Jamestown.



Top photo. The silvery banner is the highway running through the famous Black Hills of South Dakota, over Pactola Dam and by the reservoir glistening in the sun. This dam and reservoir development provides municipal water, irrigation, flood control, silt retention, recreation and is a fish and wildlife habitat.

Construction on the Yellowtail Unit, Missouri River Basin Project in Montana, is shown in this photograph taken in March. The dam is approximately 200 feet above bedrock, and erection of the structural steel in the powerplant area in the right foreground is 90 percent complete.

Groundbreaking ceremonies for Basin Electric Power Cooperative's 200,000-kilowatt Leland Olds Powerplant recently took place with spade work being done by, left to right, Art Jones, President of Basin Electric; Senator Quentin Burdick of North Dakota, Governor William Guy of North Dakota; Norman Clapp, Administrator, Rural Electrification Administration; Mrs. Leland Olds, widow of the former chairman of the Federal Power Commission for whom the plant is named; Kenneth Holum, Assistant Secretary of the Interior for Water and Power; and John Olds, son of Leland Olds.

ANNIVERSARY REFLECTIONS OF BUREAU LEADERSHIP

Five years ago this month, Floyd E. Dominy was appointed U.S. Commissioner of Reclamation. The Bureau has been credited with making significant progress since Commissioner Dominy's appointment.

Next month the Bureau celebrates the 62d Anniversary of the origin of the present-day Bureau of Reclamation with the signing of the Reclamation Act in 1902. In commemoration of these anniversaries, and in honor of the nine men who have led Reclamation to international recognition as a water resource agency, these notes are published in the *Reclamation Era.*

Commissioner Dominy

Name	*Term in office*	*Remarks*
Floyd E. Dominy, Commissioner.	May 1, 1959–	Completion of Glen Canyon, Flaming Gorge, and Navajo Dams, Colorado River Storage Project; authorization and initiation of construction of San Luis Unit and substantial completion of Trinity River Division, Central Valley Project; authorization and initiation of construction of Fryingpan-Arkansas, San Juan-Chama and Navajo Indian Irrigation Projects.
Wilbur A. Dexheimer, Commissioner.	July 13, 1953–May 30, 1959.	Congressional approval for Trinity River Division of the Central Valley Project; Colorado River Storage Project passed by Congress; Small Reclamation Projects Act of 1956 enacted.
Michael W. Straus, Commissioner.	Dec. 17, 1945–Feb. 6, 1953.	Upper Colorado River Basin Compact signed; Grand Coulee Dam and Shasta Dam dedicated; Congressional authorization for Reclamation projects in Texas and New Mexico in 1950; Reclamation's Engineering Research Center at Denver, Colo., dedicated.
Harry W. Bashore, Commissioner.	Aug. 3, 1943–Dec. 14, 1945.	Reclamation plan for development of the Missouri River Basin presented to Congress in 1944; first power from Shasta Dam Powerplant.
John C. Page, Commissioner.	Jan. 25, 1937–June 24, 1943.	Reclamation Project Act of 1939 was one of the basic laws signed by President F. D. Roosevelt; first power at Grand Coulee Dam Powerplant. Town of Page, Ariz., at Glen Canyon Dam named in his honor. Died in 1955.
Elwood Mead, Commissioner.	Apr. 3, 1924–Jan. 26, 1936.	Directed the development in whole or in part of many of the world's greatest Reclamation undertakings; Hoover Dam, 1928–36, also Grand Coulee, Owyhee, etc. Devised water law for young State of Wyoming. Lake Mead behind Hoover Dam, named in his honor. Died in 1936.
David W. Davis, Commissioner.	July 1, 1923–Apr. 2, 1924.	Name of Reclamation Service changed to Bureau of Reclamation on June 18, 1923; completion of Wind River, Horse Creek, and Malone Diversion Dams. Died in 1959.
Arthur Powell Davis, Director and Chief Engineer.	Dec. 10, 1914–June 19, 1923.	Outlined development plan for the Colorado River Basin in Congressional document in 1922; first to recommend construction of multipurpose dams whose powerplants would amortize costs of overall project. Davis Dam named in his honor. Died in 1933.
Frederick Haynes Newell, Chief Engineer, 1902–6, under Geological Survey; **Director,** 1907–14.	1902–14	Obtained Congressional authorizations on early beginnings on many Reclamation projects; first water in 1907 on both the Yakima and Salt River Projects. Died in 1932.

Region 3 in Pictures . . .

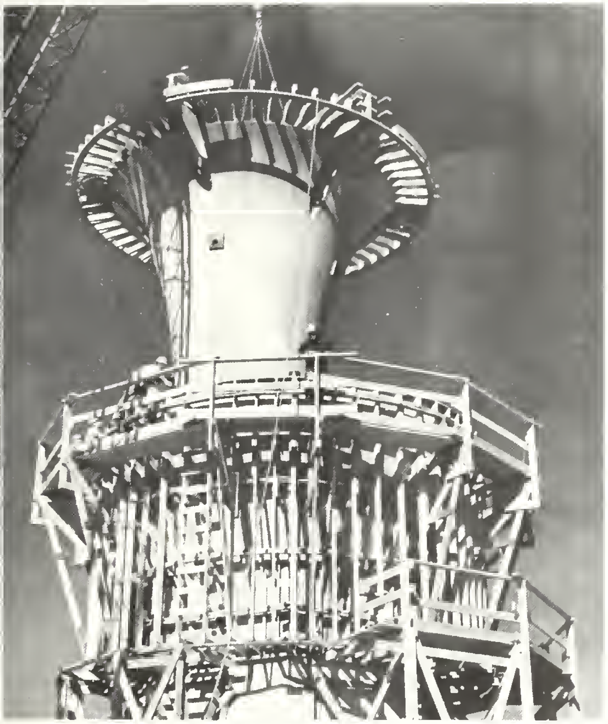
(This region includes all of Arizona except its northeastern tip, southern California, part of Nevada, New Mexico and Utah.)

Potatoes grown in the Salt River Valley south of Phoenix, Ariz., are hand sorted before sacking for market at the Wood Company packing shed. The full sacks are moved away on the belt behind the women workers.

The cotton field shown in the above picture is located south of Mesa, Ariz., and is being irrigated by siphoning from a canal. Lan such as this would still be desert without the water provided by Salt River Project.

Region 5 in Pictures . . .

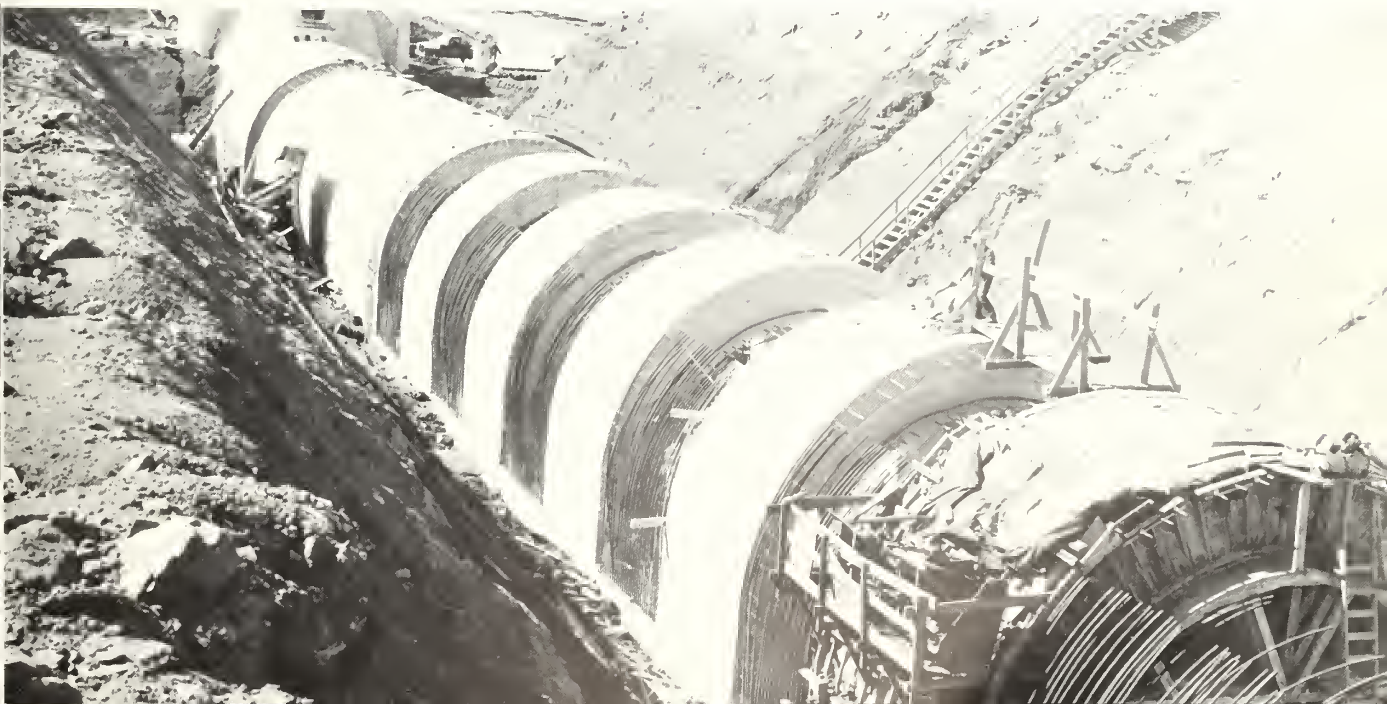
(This region includes Texas and Oklahoma, most of New Mexico, and part of Kansas and Colorado.)



Men working on the top of this structure are forming plywood for the inner surface of the glory-hole spillway intake for Cheney Dam on the Wichita Project, Kans.

Work on the Amarillo Regulating Reservoir, also on the Canadian River Project, shows the crane in the foreground, the bulldozer below, and the man near the top of the slope all helping to place riprap (large boulder-rock) on the dike slope. The crane in the background is placing concrete on the walkway for the inlet structure.

This partially completed horseshoe shaped spillway conduit and inlet structure is on the Dam Division, Sanford Dam, Canadian River Project, Tex.



MAJOR RECENT CONTRACT AWARDS

Specification No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DS-5981	Seedskadee, Wyo.	Feb. 19	Furnishing and installing one 11,111-kva generator for Fontenelle powerplant.	Mitsui & Co., Ltd., San Francisco, Calif.	$250,72
DS-5997	Water Resources Survey, Philippine Islands.	Feb. 27	Aerial photography, surveys, and topographic mapping (Negotiated contract).	Fairchild Camera and Instrument Corp., Fairchild Aerial Surveys Division, Los Angeles, Calif.	314,66
DS-6022	Colorado River Storage, Colo.	Jan. 24	Two 83,000-hp hydraulic turbines for Morrow Point powerplant.	Mitsui & Co., Ltd., San Francisco, Calif.	611,45
DC-6028	Missouri River Basin, S. Dak.-Iowa.	Jan. 7	Construction of the 75-mile Sioux Falls-Sioux City 230-kv transmission line.	Dominion Construction Co., Lincoln, Nebr.	1,992,77
DC-6032	Gila, Ariz.	Jan. 6	Construction of 9.7 miles of pipeline laterals, utilizing precast-concrete pipe for lateral GGM-18.2 and sublaterals, for South Gila Valley unit distribution system, schedule IV.	American Concrete Pipe Co., Phoenix, Ariz.	624,76
DC-6033	Central Valley, Calif.	Feb. 7	Construction of forebay pumping plant and appurtenant works and forebay dam spillway, schedules 1 and 3.	Guy F. Atkinson Co., South San Francisco, Calif.	5,067,55
DS-6035	Missouri River Basin, Mont.	Feb. 19	Furnishing and installing four 65,789-kva generators for Yellowtail powerplant.	Westinghouse Electric Corp., Denver, Colo.	2,291,14
DS-6038	Central Valley, Calif.	Jan. 8	One 200-ton traveling crane and one lifting beam for Mile 18 pumping plant.	Mitsui & Co., Ltd., San Francisco, Calif.	111,10
DS-6039	Missouri River Basin, Mont.	Jan. 30	Four 9.93-foot by 18.98-foot fixed-wheel gates for penstock intakes at Yellowtail dam.	Milwaukee Boiler Mfg. Co., Milwaukee, Wis.	197,56
DS-6040	Central Valley, Calif.	Mar. 19	Furnishing and installing eight motor-generators for San Luis pumping-generating plant.	General Electric Co., Denver, Colo.	8,953,84
DC-6041	Colorado River Storage, Wyo.	Feb. 11	Construction of Archer substation, stage 01	Wismer & Becker, Sacramento, Calif.	1,316,00
DC-6042	Colorado River Front Work and Levee System, Calif.	Feb. 18	Construction of Senator Wash dam, three dikes, and pumping-generating plant.	M. M. Sundt Construction Co., Tucson, Ariz.	5,011,53
DC-6044	Canadian River, Tex.	Feb. 25	Construction of pumping plants Nos. 1, 2, 3 and 4	Coastal Bend Construction Co. and Electric Construction Co. Inc., Corpus Christi, Tex.	2,669,89
DC-6045	Missouri River Basin, Kans.	Mar. 2	Construction of Cawker City diversion drain	Van Buskirk Construction Co. and Graves Construction Co., Inc., Sioux City, Iowa.	350,46
DC-6047	Missouri River Basin, Nebr.	Mar. 5	Construction of 40 miles of Ainsworth laterals and wasteways, section 2.	Bushman Construction Co., St. Joseph, Mo.	1,354,28
DC-6048	Missouri River Basin, S. Dak.	Mar. 17	Construction of New Underwood substation, stage 01	Marson Construction Co., Inc., Indianapolis, Ind.	1,237,77
DC-6050	Boulder Canyon, Nev.	Feb. 26	Installation of transformer "Z" in Hoover powerplant and construction of 69-kv transformer circuit No. 15 and Nevada State switchyard additions.	Nebr. Commonwealth Electric, Inc., Omaha, Nebr.	167,40
DC-6051	Missouri River Basin, Minn.	Mar. 6	Construction of stages 07 and 08 additions to Granite Falls substation.	Electrical Builders, Inc., Valley City, N. Dak.	158,48
DC-6052	Parker-Davis and Colorado River Storage, Ariz.	Mar. 20	Construction of stages 02 and 03 additions to Mesa substation.	Wismer & Becker, Sacramento, Calif.	476,00
DC-6054	Missouri River Basin, S. Dak.	Mar. 12	Stringing conductors and overhead ground wires for the 146-mile Fort Thompson-Sioux Falls 230-kv transmission line.	Commonwealth Electric Co., Lincoln, Nebr.	2,974,35
DS-6058	Colorado River Storage, Colo.	Mar. 12	One 250-ton traveling crane for Morrow Point powerplant.	Puget Sound Bridge & Dry Dock Co., Colby Crane & Mfg. Co. Division, Seattle, Wash.	137,75
DC-6059	Columbia Basin, Wash.	Mar. 23	Construction of 15.6 miles of blended earth-lined laterals and 7.3 miles of concrete-lined laterals for block 81—part 1 laterals and wasteway, West canal laterals.	Floyd Williams, Inc., Kennewick, Wash.	894,74
DS-6060	Office of Chief Engineer, Denver, Colo.	Feb. 27	Architectural and engineering services for Bureau of Reclamation office building at the Denver Federal Center, item 1 (negotiated contract).	Hellmuth, Obata, and Kassabaum, Inc., St. Louis, Mo.	284,00
300C-192	Delivery of Water to Mexico, Ariz.	Jan. 31	Construction of concrete pipelines for farm drain tile collection system, Wellton-Mohawk area.	Karl A. Dennis, dba Dennis Construction Co., Yuma, Ariz.	132,91
300C-206	Colorado River Front Work and Levee System, Arizona	Feb. 12	Rebuilding portion of the north embankment and placing riprap on the north bank of main outlet drain.	Gil-Brown Constructors, Inc., Phoenix, Ariz.	224,46
500C-150	Norman, Okla.	Mar. 13	Construction of boat launching ramps and comfort stations for recreational facilities for Norman reservoir.	Pool Construction Co., Shawnee, Okla.	253,24
500S-156	Lower Rio Grande Rehabilitation, Tex.	Mar. 10	169,000 feet of unreinforced and 800 feet of reinforced concrete pressure pipe, and 1,900 feet of concrete culvert pipe for LaFeria division.	W. T. Liston Co., Harlingen, Tex.	540,36
500S-158	Lower Rio Grande Rehabilitation, Tex.	Mar. 13	262,300 feet of unreinforced and 15,120 feet of reinforced concrete pressure pipe, and 2,592 feet of concrete culvert pipe for Mercedes division.	Valley Concrete Pressure Pipe, Co., Harlingen, Tex.	886,66
700C-576	Missouri River Basin, Neb.	Mar. 4	Construction of 8 miles of access road, timber bridge, parking areas, toilets, and boat launching ramp for recreational facilities for Merritt dam and reservoir, schedules 1, 2, and 4.	Franke Construction Co., Inc., Mullen, Nebr.	178,41
DC-6062	Central Valley, Calif.	Mar. 25	Increased storage modifications for Shasta dam	George R. Osborn Construction Co., Redding, Calif.	124,04
500C-152	Canadian River, Tex.	Mar. 24	Clearing 14,000 acres of Sanford reservoir site	M. C. Winters, Inc., Johnson City, Tex.	132,75
600C-204	Missouri River Basin, Wyo.	Mar. 23	Clearing 5,670 acres of Yellowtail reservoir site	Humphrey Contracting Corp., Wichita, Kans.	104,00

U.S. GOVERNMENT PRINTING OFFICE : 1964 O—724-672

Major Construction and Materials for Which Bids Will Be Requested Through May 1964*

Project	Description of work or material
Canadian River, Tex.	Constructing about 140 miles of 8- to 72-in.-diameter pipeline of either non-cylinder prestressed concrete pipe, steel cylinder pretensioned concrete pipe, steel pipe, concrete pressure pipe, or asbestos-cement pipe. Lubbock to Lamesa and Southwest Aqueduct, near Lubbock.
Central Valley, Calif.	Constructing about 34 miles of 75-ft bottom width canal to be lined with 4.5-in. unreinforced-concrete lining and appurtenant structures including concrete bridges, pipe crossings, and checks. San Luis Canal, Reach 3, near Los Banos.
Do	Flood bypass channel restoration and constructing a concrete roadway slab and weir protected by riprap. On the Sacramento River, near Red Bluff Dam, about 2 miles downstream from Red Bluff.
Do	Seven 100,000-kva, 3-phase, 330- to 13.8-kv, OA/FA power transformers for San Luis and Mile 18 Switchyards.
Do	Four hydraulic hoists for 17.5- by 22.89-ft roller-mounted gates for San Luis Dam Pumping-Generating Plant. Estimated weight: 530,000 lb.
Do	Four 17.5- by 22.89-ft roller-mounted gates for San Luis Dam Pumping-Generating Plant. Estimated weight: 620,000 lb.
Do	One 23- by 28.5-ft two-section bulkhead gate; gate frames for four openings, and one lifting frame for San Luis Dam. Estimated weight: 465,000 lb.
Do	Four 17.5- by 22.89-ft frames for roller-mounted gates for San Luis Dam Pumping-Generating Plant. Estimated weight: 250,000 lb.
Do	Eight 14.4-kv station-type switchgear; 15-kv isolated-phase bus; two 2,000-kva, 13.8-kv to 4,160-wye/2,400-volt station-service transformers; 600-volt non-segregated-phase bus for San Luis Reservoir Pumping-Generating Plant.
Do	Main control boards and unit control boards for San Luis Reservoir Pumping-Generating Plant.
CRSP, Arizona	Constructing about 114 miles of 345-kv, single-circuit transmission line will consist of clearing right-of-way; constructing concrete footings; furnishing and erecting steel towers; furnishing and stringing three ACSR conductors—77 miles of 954 MCM, 34 miles of 1,033.5 MCM, and 3 miles of 2,167 MCM; two steel-strand, overhead ground wires—111 miles of 0.5-in., high-strength, and 3 miles of 7/16-in. extra-high-strength; and furnishing and installing fence gates. Flagstaff-Pinnacle Peak No. 2 Transmission Line, from vicinity of Flagstaff to vicinity of Phoenix, Ariz.
Do	Constructing about 124 miles of 345-kv, single-circuit transmission line will consist of clearing right-of-way; constructing concrete footings; furnishing and erecting steel towers; furnishing and stringing three ACSR conductors—120.5 miles of 954 MCM, 3 miles of 1,033.5 MCM, and 0.5 mile of 2,167 MCM; two steel strand overhead ground wires—123.5 miles of 0.5-in., high-strength, and 0.5 mile of 7/16-in., extra-high-strength; and furnishing and installing fence gates. Glen Canyon-Flagstaff No. 2 Transmission Line, from Glen Canyon Switchyard to vicinity of Flagstaff, Ariz.
Do	Six 345-kv, 1,600-amp, 25,000-mva power circuit breakers for Flagstaff Substation.
CRSP, Colorado	Furnishing and installing two 33,333-kva, 0.9-pf, 200-rpm, 60-cycle, vertical-shaft, hydraulic-driven, a-c generators for Blue Mesa Powerplant.
Do	Two 216,500-ft-lb cabinet-type actuator governors for regulating the speed of two 83,000-hp turbines for Morrow Point Powerplant.
Columbia Basin, Wash.	Constructing about 37 miles of open laterals with bottom widths varying from 10 ft to 2 ft, of which about 21 miles will be lined with unreinforced-concrete lining and about 14 miles will be lined with compacted earth lining. Block 81 Laterals, Part II, near Othello.
Do	Constructing the Low Gap Pumping Plant with a 78- by 44-ft superstructure housing four horizontal-shaft, motor-driven pumping units as follows: 2 at 29 cfs each at 72-ft head, 1 at 14.5-cfs at 72-ft head, and 1 at 8.9 cfs at 72-ft head. Furnishing and installing six additional horizontal-shaft, motor-driven pumping units in the existing
Columbia Basin, Wash.—Continued	Frenchman Hills Pumping Plant as follows: 1 at 65.28 cfs at 170-ft head, 3 at 39 cfs at 313-ft head, and 1 at 20.5 cfs at 313-ft head. About 30 miles northwest of Othello.
Emery County, Utah	Constructing the reinforced-concrete Swasey Diversion Dam consisting of an ogee overflow weir 75 ft long, a canal headworks structure with two 72- by 48-in. cast iron slide gates, a sluiceway structure with one 10- by 10-ft radial gate, and about 800 ft of compacted earth dikes; and earthwork and structures for about 3.6 miles of the 12-ft bottom width Cottonwood Creek-Huntington Canal, part of which will be lined with buried asphalt membrane lining. Near Castle Dale.
Fryingpan-Arkansas, Colo.	Constructing Ruedi Dam, a 3,000,000-cu-yd earthfill structure, about 280 ft high and about 1,000 ft long, and appurtenant features. The spillway will consist of an inlet structure with a 25-ft ogee crest, chute, and stilling basin in the right abutment. The exit tunnel for the auxiliary outlet works will discharge through the spillway floor and will be regulated by a single gate. The service outlet works will consist of an intake structure, a 10-ft-diameter pressure tunnel, and a 76-in. diameter outlet pipe downstream of a gate chamber in an open 11-ft-diameter tunnel with a stilling basin. Work will also include earthwork, structures, and surfacing for about 9 miles of county road. On the Fryingpan River, 16 miles east of Basalt.
MRBP, Montana	Furnishing and constructing about 47 miles of the 115-kv, woodpole Lovell-Yellowtail Transmission Line; and furnishing and stringing three 556.5 MCM, 24/7, ACSR conductors, and two 3/8-in., high-strength, steel strand, overhead ground wires. From Yellowtail Switchyard, about 45 miles southwest of Hardin, Mont., to Lovell Substation, near Lovell, Wyo.
Do	Three single-phase, 230-grd wye—115-grd wye-kv, 26,000/34,667/43,333-kva, 13.8-kv, 5,400/7,200/9,000-kva autotransformers for Yellowtail Switchyard.
Do	Three 50,000-kva, 230-grd wye—13.2-delta-kv, single-phase, 60-cycle, FOW transformers; and three 50,000-kva, 115-grd wye—13.2-delta-kv, single-phase, 60-cycle, FOW transformers for Yellowtail Switchyard.
Do	One 90-ton-capacity gantry crane for Yellowtail Dam. Estimated weight: 195,000 lb.
Do	Main control, relay and graphic boards for Yellowtail Powerplant.
MRBP, Nebraska	Constructing about 62 miles of laterals with bottom widths varying from 16 to 3 ft, part of which will be lined with compacted earth lining. Ainsworth Laterals, Third and Fourth Sections, near Ainsworth.
MRBP, Wyoming	Constructing the Lyman Substation will consist of constructing a concrete masonry service building; constructing foundations; furnishing and erecting steel structures; furnishing and installing one 10-mva, 115/345-kv transformer, three 34.5-kv circuit breakers and associated electrical equipment; and grading and fencing the area. At Yoder.
Parker-Davis, Ariz.	Furnishing and constructing about 14 miles of the 115-kv, woodpole Coolidge-ED-2 Transmission Line; and furnishing and stringing three 927.2 MCM aluminum alloy conductors (5005-H19 alloy) and two 3/8-in., high-strength, steel strand, overhead ground wires. From Coolidge Substation, near Coolidge, to ED-2 Substation, southwest of Coolidge.
Do	Constructing the Signal Substation will consist of constructing foundations; furnishing and erecting steel structures; furnishing and installing three 115-kv disconnnect switches, and associated electrical equipment; and grading and fencing the area. Additions to ED-2 Substation will consist of constructing foundations; furnishing and erecting steel structures; and furnishing and installing three 115-kv disconnect switches ,and associated electrical equipment.
Silt, Colo.	Constructing Rifle Gap Dam, a 1,800,000-cu-yd earthfill structure about 125 ft high and 1,500 ft long, and appurtenant features. Work will also include relocating about 4 miles of State Highway No. 325. On Rifle Creek, about 7 miles north of Rifle.

*Subject to change.

What's Coming:

Keeping a Project in Shape

In its assigned function as the Nation's principal natural resource agency, the Department of the Interior bears a special obligation to assure that our expendable resources are conserved, that renewable resources are managed to produce optimum yields, and that all resources contribute their full measure to the progress, prosperity, and security of America, now and in the future.

U.S. Department of the Interior
Bureau of Reclamation

August 1964

Reclamation ERA

Reclamation ERA

AUGUST 1964

Volume 50, No. 3

OTTIS PETERSON, Assistant to the Commissioner—Information
GORDON J. FORSYTH, Editor

COVER PHOTO—showing impressive flowers and palm trees might be as pleasing as this in any one of Reclamation's Southern States. But the near-fluorescent field of commercial flowers are in the Salt River project area, Arizona. Harvesting at the peak of the season from January through Easter requires 100 trained workers. Photo by J. R. Cotterill, March 1964

United States Department of the Interior
Stewart L. Udall, Secretary

Bureau of Reclamation, Floyd E. Dominy, Commissioner

Washington Office: United States Department of the Interior, Bureau of Reclamation, Washington, D.C., 20240.

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Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C., 20240. Use of funds for printing this publication has been approved by the Director of the Bureau of the Budget, January 31, 1961.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Price 15 cents (single copy). Subscription price: Eight issues (2 years) for $1.00 ($1.50 for foreign mailing).


White plume trailing plane shuttling over Elephant Butte Reservoir, N. Mex., is hexadecanol, which forms an invisible "lid" on the water.

THE "SKIN" THAT SAVES WATER

by BILL HOSOKAWA
Associate Editor of the *Denver Post*, Editor of Sunday Empire

ONE sunny day not long ago, I watched a chunky, broadshouldered man walk to the windward shore of a reservoir, take handfuls of fluffy white powder from a paper sack, and cast it over the water like an old-time farmer sowing grain. When he had emptied the bag, the two of us hiked up a nearby hill to view the results.

Long before we reached the crest, the powder had vanished. But close to shore, where it had been scattered, the water was smooth and glassy. Farther out, ripples marred the surface.

"That's what gets the job done," Walter Urban Garstka explained. "The powder turns quickly into a very thin, invisible film—a film just one molecule thick. The only way you can tell it's there is that it quiets the water.

"That film could be the salvation of many water-short regions of the world."

Walter Garstka is probably as well qualified as any living person to make so sweeping a statement. As chief of the U.S. Bureau of Reclamation's water conservation research division, he has been studying the problem of evaporation control a dozen years. He has demonstrated that the immense loss of water from lakes and reservoirs through evaporation can be reduced, and engineers and scientists from the world's thirsty nations have beaten a path to the Denver laboratories to learn how it is done.

All of us are familiar with the phenomena of evaporation. Leave a saucer of water uncovered, and gradually the water turns into vapor and disappears. Evaporation is a never-ending process necessary to replenish moisture in the atmosphere so it can be redistributed over the earth as rain and snow.

The cruel thing about evaporation is that it steals water indiscriminately—from the jealously hoarded reservoirs in the arid plains as well as the limitless oceans. In fact, the rate of evaporation is greatest where the humidity is lowest and water most precious.

An astounding amount of water is lost by evaporation. Water scientists tell us the average precipitation across the United States is about 30 inches a year. We consume only one-tenth of this amount—3 inches. Six inches flows into the sea.

The rest—21 inches—evaporates from the soil, through the transpiration of plant life, from lakes and rivers and even snowbanks. Day after day this invisible, perpetual "reverse rainstorm" sucks life-sustaining moisture from the earth's surface into the sky.

There isn't much that can be done about evaporation from the soil and through the normal

(*Reprinted from the* Sunday Empire, April 12, 1964.)

"breathing" of plants. But control of evaporation from lakes and reservoirs—which is what Garstka's white powder can do—could revolutionize the economy of vast regions.

Compare Los Angles Needs

Take rain-scarce Southern California, whose sprawling cities and farms are nurtured by water piped in from the Colorado River. The evaporation loss from Lake Mead, the huge storage reservoir on the Colorado behind Hoover Dam, is almost as great as the torrent that pours through the mains to slake Los Angeles' thirst—700,000 to 900,000 acre-feet annually.

An acre-foot is the water it takes to flood an acre to a depth of 1 foot—325,851 gallons. A rule of thumb among water engineers is that an acre-foot will supply the needs of four persons for 1 year. Taking the lower figure of 700,000 acre-feet, the water Lake Mead loses by evaporation could, if saved, support a metropolis of 2.8 million—a population equal to that of Iowa.

Plight of Parched Areas

In some parts of the world, as many as 6 gallons of water impounded in reservoirs is lost by evaporation for every gallon consumed. More than half the fresh water flowing into parched Israel evaporates before it can be used. Similar figures are available for thirsting India, Pakistan, Egypt, Australia. One recent study in Oklahoma showed that evaporation loss from farm ponds is 10 times greater than the amount a farmstead uses. J. Stuart Meyers, in a U.S. Geological Survey report, estimates the annual evaporation loss from streams, lakes, and fresh-water reservoirs in the 17 Western States is more than 23.6 million acre-feet—enough to meet the needs of half the population of the United States.

This is water we can ill afford to lose, especially in years like this when drouth threatens, for water holds the key to this Nation's continued development. The Nation is, in fact, running short of water. In vast basins of the West, all available water already is committed, and their growth is blocked unless more water is made available. In parts of the Mississippi and Ohio Valleys, the need is so great that the same water is used, recycled and reused six and seven times in domestic systems before it ultimately reaches the sea. Even in the East, where precipitation normally balance use and evaporation, additional water is bein sought for domestic and industrial purposes. Th only "new" source, aside from distilling sea wate or piping fresh water from distant watersheds a California already is doing—and both of thes methods are enormously costly—is in reducing th evaporation loss.

Ramrodded by Garstka

A Bureau of Reclamation task force ramrodde by the bald, energetic, cello-playing Garstka ha come up with the likely answer, a mysterious, in visible, monomolecular film. This is a chemica "skin" only one molecule thick—an incredible si ten-millionths of an inch. Spread over the sur face of reservoirs, it is an antievaporation barrie like a lid over the saucer in our evaporation dem onstration. It does not halt all evaporation, bu in scores of minutely observed field tests under a manner of trying conditions, the film has show it can conserve significant amounts of wate Evaporation loss was reduced by an average o 10 percent, and as much as 22 percent. Despit the handicap of low-efficiency experimental equip ment for spreading the film, the cost of water save was well within practical limits.

"We have a method that works," Gartska tol me, gesticulating vigorously. "The cost is rea istic. It is safe for people. It does not har wildlife or interfere with recreational use of lake Now, how rapidly evaporation control with mon molecular film becomes common practice depend on how badly we need water and how much w are prepared to spend to conserve it."

Several materials can be used for the chemica film, but the most widely employed is a family o what are called long-chain or "fatty" alcohol They are a nonintoxicating substance familiar t industry.

The two forms Garstka has found most effecti are hexadecanol and its close cousin octadecano They are made from petroleum as well as whale oi tallow and palm oil. At room temperature, hexa decanol is a white, waxy solid insoluble in wate It finds wide use in lipsticks, hand lotions an other cosmetics.

Hexadecanol and octadecanol are scattered i powder form over the water to be protected, or the can be melted and sprayed. The molten materia solidifies almost immediately after leaving the noz

zle, falling on the water like a dust cloud which quickly becomes invisible.

Shaped Like Shotgun Shells

In the Bureau of Reclamation laboratories, I learned how the hexadecanol works. Its molecules are shaped something like shotgun shells. These molecules float upright, compressed shoulder to shoulder, forming the film. Although it inhibits the passage of water vapor, for some unknown reason the film does not interfere with the natural movement of carbon dioxide, oxygen, and other gases.

To demonstrate how the molecules spread out to form the film, Garstka sprinkled some cedar shavings from a pencil sharpener into a pie tin half filled with water. The shavings floated where they landed. Then he dropped some powdered hexadecanol on the water, where it became invisible on contact. Instantly the shavings darted toward the edges of the pan, forced out by the spreading film.

As happens so often in scientific research, Garstka stumbled on hexadecanol while seeking a solution to another problem. In 1952, he was working on rain gages for an automatic flood-warning system in north California. When water reached a certain level in the precipitation gages scattered over key watersheds, an electrical signal would be transmitted. On receipt of this warning, upstream reservoir releases could be reduced to make room in stream channels for the expected flood pouring out of the mountains. (This subject was formerly developed in "Pushbutton Flood Control," *Reclamation Era*, February 1954.)

A Clue to the Solution

But for the warnings to be accurate, evaporation from the rain gages had to be kept at a minimum. Garstka was looking for something to curb evaporation when he read papers published some years earlier by Irving Langmuir and V. J. Schaefer reporting on laboratory findings about hexadecanol's remarkable properties. Garstka reasoned that if hexadecanol could control evaporation in the laboratory, it ought to work in a rain gage or a lake for that matter. Forthwith, he turned his curiosity loose on the subject.

About the same time, two other scientists were studying evaporation control without knowledge of either Garstka's or each other's activities.

Smooth water behind raft-mounted dispensers on Lake Cachuma, Calif., shows effect of hexadecanol.

W. W. Mansfield, a chemist in the Australian Government's Commonwealth Scientific and Industrial Research Organization, was one. The other was Dr. Victor K. LaMer of Columbia University. All three reached the same conclusion independently: A thin chemical film placed on the surface of lakes and reservoirs holds promise of reducing evaporation.

But a great deal had to be learned before the idea could be applied.

By 1956, the Bureau of Reclamation had launched a full-scale attack on the problem with its extensive research facilities, in cooperation with various State and Federal agencies, and through Federal grants to nearly a dozen universities interested in working on special aspects of the project.

Key members of the Bureau's team included Quentin L. Florey, co-inventor of apparatus and techniques used in the experiments; H. Dean Newkirk now head of the evaporation-reduction unit, and G. E. Burnett, chief research scientist. The research center is part of the office of B. P. Bellport, chief engineer.

The behavior of so diaphanous a thing as a monomolecular film had to be studied under rigorous field conditions. Lengthy tests had to be undertaken to determine its effectiveness and its resistance to sun and wind. The effect of hexadecanol on fish, waterfowl, plankton, and insects had to be determined. And ways had to be devised for spreading the hexadecanol over reservoirs stretching across tens of thousands of acres. Costs had to be computed.

Gradually the reports began to come in—from Lake Mead, from Rattlesnake Reservoir in Colo-

Walter U. Garstka

rado, Sahuaro Lake in Arizona, and many other research sites. The findings were encouraging. The U.S. Public Health Service reported that hexadecanol, in the amounts used posed no health hazard. Colorado State University experts found wildlife was unaffected by it. In fact, fish were seen feeding on concentrations of hexadecanol. Swimmers, skiers, and boaters welcomed it because it smoothed the water. The film healed itself within minutes after a boat cut through it.

Reduced by 22 Percent

The amount of water saved varied widely. The best showing was at Lake Cachuma near Santa Barbara, Calif., where evaporation was reduced by 22 percent at a cost of $28 per acre-foot—far less than the water was worth to the city. Under laboratory conditions, evaporation had been reduced by as much as 64 percent.

But many problems become apparent, too, mainly in spreading the film and maintaining it. Winds above 20 m.p.h. crumpled the film, and even 15-m.p.h. breezes tended to wash it ashore. In small ponds with much biological activity, what the scientists referred to as biological attrition became serious. At Lake Hafner in Oklahom 40,000 pounds of hexadecanol disappeared in months, apparently gobbled up by the microscopi creatures in the water. In some stock ponds, th organisms ate up the film overnight.

Generally, however, Garstka learned his theor was sound, and the principal difficulties wer engineering problems—how to dispense the fil cheaply and keep it on the water.

So far, no way has been found to toughen th film so that it resists wind damage. Nor have th scientists found a material that will redistribut into a monolayer once it has been severel crumpled. But hexadecanol is inexpensiv enough to scatter as often as necessary. It cost about 40 cents per pound, and only one-fifth t one-half pound covers an acre. If large quantitie of hexadecanol were to be manufactured, Garstk estimates it could be produced for as little as 1 cents a pound.

Distributing it poses a greater problem. Smal reservoirs can be kept covered by a man tossing ou powdered hexadecanol by hand, as Garstka di with the aid of a light breeze, but a man's time i costly and a favorable wind isn't always availabl Motorboats have been used successfully, but her again manpower is involved. Automatic dis pensers aboard anchored rafts, which operate onl when the wind direction and velocity are favor able, have been found practical and require minimum of attention. Two Utah State Uni versity professors demonstrated that a light plane flying 25 to 50 feet above the water at speeds o 100 m.p.h. can blanket large reservoirs at the rat of 100 acres a minute.

Speaking at a UNESCO symposium on evapora tion control at Poona, India, Garstka told dele gates from many water-short nations:

"It is not reasonable to expect that one sub stance or one technique would be the best for al reservoirs. The fact that at present our prim attention is concentrated on the use of monomo lecular layers does not mean that they are the ulti mate in evaporation-loss-reduction techniques."

He pointed out that engineers must develop dif ferent techniques for applying and maintainin different kinds of film to meet the needs of variety of local conditions. Research toward thi end is continuing. But in the United States, a least, evaporation reduction is practical today.

(Continued on page 55)

Innovations in AQUEDUCT CONSTRUCTION on the Canadian River Project

by V. O. GRANTHAM
Assistant Project Construction Engineer, Amarillo, Tex.

COULD there be a "production line" method of installing large diameter, concrete pressure pipe? It is believed a new "deep cradle" method now being utilized to lay prestressed concrete pipe on the Bureau's Canadian River project is just that. Twenty-two foot sections of 72- and 78-inch diameter pipe is used.

Construction was initiated in January 1963 of the initial 57-mile section of the 322-mile aqueduct system to deliver water to the 11 high plains cities comprising the Canadian River Municipal Water Authority. The R. H. Fulton Co. of Lubbock, Tex., was awarded the contract.

Acting on the suggestions of Project Construction Engineer C. O. Crane, the contractor developed a machine for cutting a semi-circular trench that would precisely fit the lower shape of the pipe. After experimenting briefly with a small "made-on-the-job" cradle excavating machine, the contractor called in engineers from the Barber-Greene Co. and presented the problems and the Bureau's proposal for the manufacturer's study.

Before the first mile of pipe had been laid, a new machine had been built and placed in service. This machine is now known as the modified Barber-Greene Model T. A. 55-wheel excavator, and it cuts a cradle about one-third of the outside pipe diameter in depth, with radius 3 inches greater than the outside pipe radius. A standard wheel excavator was modified by attaching two special shaped cutters to the ends of an axle geared to the excavation wheel. These cutters excavate to the edge of the wheel buckets, thus producing an extremely smooth circular cradle.

The excavator is track-mounted and self-propelled.

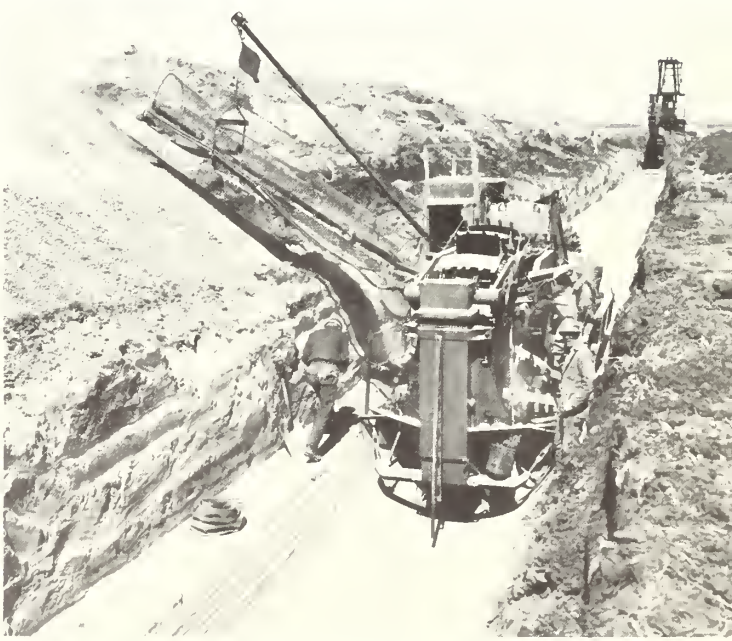
A crumbing shoe, shaped to fit the cradle circumference, is attached to the rear of the excavator and collects spillage from the cutters. There is no necessity for cleanup operations behind the machine. Originally, to place the excavated spoil material on the bank, the excavator was equipped with an 8-foot conveyor, and 24-inch belt. Later, because of the height of the spoil bank, it was deemed advantageous to increase the conveyor length to 12.5 feet.

The firm to medium consistency of the soil encountered in the area is ideal.

The New Method

To install pipe utilizing the deep cradle method, a 10-foot-wide trench is excavated with a 4-cubic-yard backhoe to a depth of approximately 40 inches above the bottom grade of the pipe. The modified Barber-Greene trencher is then used to complete the cradle excavation.

Excavated soil is elevated to the top of the spoil bank by the conveyor arm at left.



The machine leaves the bottom of the deep cradle clean.

In laying the concrete pipe, the individual sections are supported on small sand pads located in the bottom of the cradle at approximately 2 feet from each end of the pipe section to be set. A hand-operated winch secured in a previously laid pipe section, and with a cable extending forward to a 6 x 6-inch timber placed across the open end of the pipe section to be set, is used to draw the pipe sections together to complete joint closure.

After the pipe section has been forced horizontally into place at the joint, and the O-shaped rubber gasket confined in its groove to assure positive seal against water pressures up to 195 pounds per square inch, the outer end of the pipe is adjusted to perfect horizontal and vertical alinement, by tamping small amounts of sand around the pipe at the location of the sand pad support. Alinement of the pipe is thereby made unusually precise with less than normal effort.

The procedure also deviates from conventional practices in backfilling under the pipe. Past operations necessitated compacting pipe bedding by laborious hand tamping of properly placed and moistened earth material around and underneath the lower portion of the pipe. The annular 3-inch space between the pipe and the circular trench, is now being pumped full of mortar in the proportions of two bags of cement per cubic yard of sand

as mixed to a slurry by adding water in a model 16-S mixer. The mortar is first pumped into the annular space on one side. Before the first side is completely filled, the mortar is pumped into the other side. Consolidation of the mortar is accomplished by a portable electric vibrator with a flexible shaft. Tests indicate the resulting mortar bedding has a bearing strength of approximately 300 pounds per square inch.

Contractor's Progress

It is estimated that the contractor's progress through these innovations is double that of the previously used conventional methods. The cost of laying and bedding pipe has been reduced to approximately one-third of other standard methods, and it is felt that the Bureau now obtains a better job as a result of more uniform and impervious support under the pipe with no void spaces near the bottom support to permit passage of drainage or seepage water.

In the first meeting with the new Reclamation contractor, speculation was made as to the length of pipe that could be laid in one day. The project construction engineer told the contractor that he would buy him a steak dinner the day that 1,000 feet of pipe were installed in one shift. Before 10 miles were installed, the steak was demanded. A length of 1,628 feet was laid during one 9-hour working day. While this is the maximum footage to be installed in one shift, it has become fairly routine to install 1,100 to 1,300 feet of pipe during the regular 9-hour working day.

The noncylinder prestressed concrete pipe for installation under the H. R. Fulton Co. contract is being manufactured at the Amarillo plant of Gifford-Hill-American, Inc. The balance of the 322-mile aqueduct system will be built under three other principal contracts. Each contract will be sufficiently large to warrant development of and investment in new equipment and methods. Already other innovations are on the drawing board and may prove equally as advantageous and economical for the work on the Canadian River project.

The total estimated construction cost of the Canadian River project is $96 million. Approximately two-thirds of this amount will be expended to construct the aqueduct system and appurtenant facilities, and the balance will be required to complete construction of Sanford Dam. # # #

Slurry mixed mortar is pumped into the annular space on both sides of the pipe.

The "Skin" that Saves
(Continued from page 52)

And the Price Is Right

A recent Bureau of Reclamation report to the Senate Committee on National Water Resources points out that the cost of water for irrigation ranges from $1 to $35 per acre-foot, and from $5 to more than $75 for municipal use. (Denver was offered $90 an acre-foot last summer by a drouth-stricken suburb. The Denver Water Board declined to sell for less than $150 per acre-foot.) Water engineers estimate that even without major scientific breakthroughs, and using techniques known today, evaporation in the United States could be reduced by 2 million acre-feet annually, at a cost of between $20 and $35 per acre-foot—from 6 to 10 cents for 1,000 gallons.

"At these costs," Garstka says, "the reduction of evaporation loss by chemical means could very rapidly become a routine method of conserving water in many parts of the world. And without water there is no life." # # #

FLAMING GORGE . . .
New Rainbow Bonanza

by **BOB WILEY**
of the Wyoming Game and Fish Department

ONE of the larger bodies of water in the Western United States, Flaming Gorge Reservoir, offers the fisherman a variety of places to test his favorite lure. Stocked in 1963 with more than 3½ million rainbow trout, the lake is now yielding excellent catches to nearly all fishermen.

As on most Wyoming reservoirs, Flaming Gorge may be fished on open water in summer or through the ice in winter. Fishing with fly, bait, or lure, from boat or shore, during the summer promises to be rewarding in numbers of fish as well as in weight. Trout planted last year as fingerlings are now averaging a fat 12 inches, large enough to please most anglers.

The winter fisherman, with his sometimes elaborate gear, can be seen on the ice from December through March. At the close of a typical day these fishermen usually leave the ice with a smile and a full creel.

The sightseer, picnicker, and boater, as well as the ardent angler, will find spots to his liking along the entire reservoir. The 30-mile section in Utah will attract many people to its beautifully colored canyons, deep waters, and interesting geological formations. Each mile of this section should present the fisherman with intriguing places to cast his lure.

Many miles of shoreline and secluded bays await the fisherman in the Wyoming portion of the lake. Each bay, with its sage lined banks, will seem to the angler the place to test his tackle with the fighting rainbow of Flaming Gorge.

Convenient launching ramps and docking facilities have been installed by the U.S. Forest Service and National Park Service. Other facilities necessary for the visitor are being planned.

Currently Utah and Wyoming State conservation agencies are undertaking an extensive study

The reservoir behind Flaming Gorge Dam was 332 feet deep when this picture was taken.

of Flaming Gorge waters. Physical, chemical, and biological aspects of the lake are being observed closely to increase knowledge of aquatic life in this new impoundment. Fish stocking plans for the future are being formulated to enhance the present fishery.

Lake Regulations

Before coming to the Flaming Gorge Bonanza all anglers should read their Wyoming's regulations carefully to fully understand the special regulations in effect on the lake.

Wyoming anglers planning to fish the Utah portion of Flaming Gorge Reservoir must purchase a special Utah fishing reciprocity stamp in addition to their regular Wyoming fishing license. The $2.00 stamps will be available from license-selling agents in southwestern Wyoming. Other regulations for the reservoir:

A resident of Wyoming or Utah under 12 may fish the reservoir in either State without a license or stamp. A nonresident under 12 may fish without a license or stamp, but he must be accompanied by an adult with a valid license and his catch will be counted as part of the adult's creel limit.

Wyoming or Utah residents 12 or 13 years old may fish without licenses, but they must have reciprocity stamps to fish that portion of the reservoir lying in the other State. Wyoming residents 12 or 13 years old need neither licenses nor stamps if they fish in Wyoming.

A Wyoming resident 14 to 19 years old may fish Wyoming's portion of the reservoir if he has a Wyoming resident youth fishing license. He may also fish in Utah's portion of the reservoir if he has a Utah fishing reciprocity stamp.

The creel limit is 10 game fish or 7 pounds and 1 game fish a day or in possession. Residents of either state under 12 may take four game fish or 3 pounds and one game fish a day or in possession.

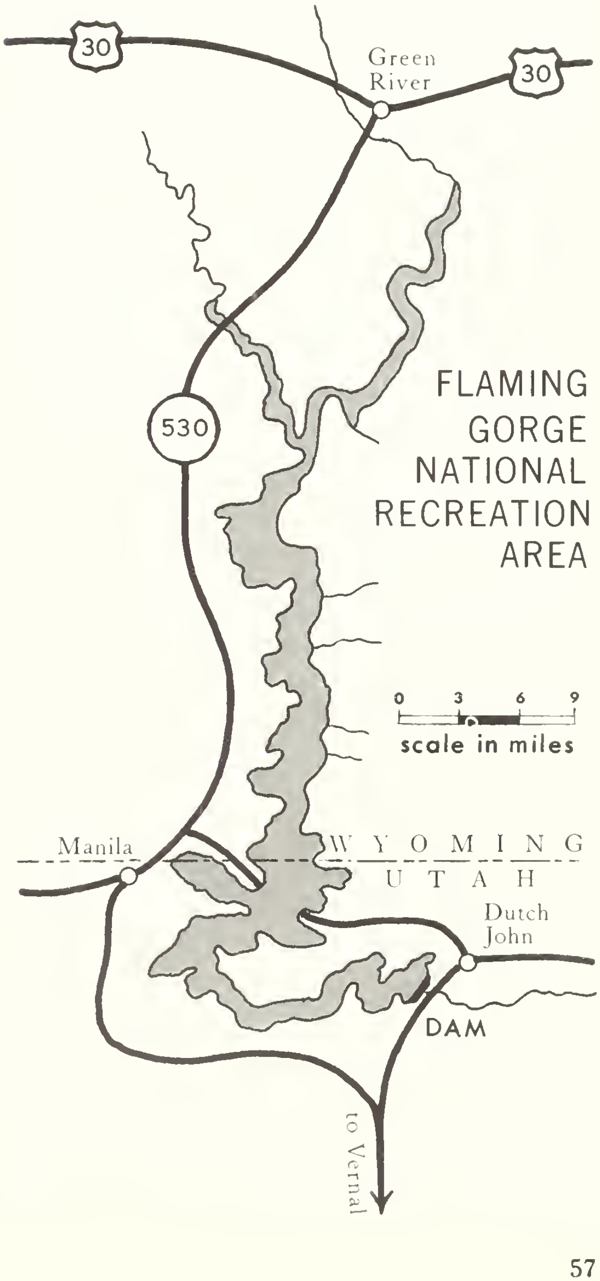
Fishing is permitted throughout the calendar year to elevations of 6,040 feet, as designated by Game and Fish Commission markers.

The possession or use of live fish for bait, the use or possession of salmon eggs or corn for bait, and the use of more than three baited hooks on each line is prohibited.

Set-line fishing through a hole in the ice is permitted, provided only one line with no more than three hooks attached is used and provided the owner attends the line. # # #

Bob Wiley

Mr. Wiley, 23, is an assistant fisheries biologist with the Wyoming Game and Fish Department. For the last several months he has assisted the Department's Fisheries Management Crew No. 4 with a study of Flaming Gorge Reservoir. Wiley is a graduate of Humboldt State College at Arcadia, Calif. His article is reprinted by his permission and that of *Wyoming Wildlife*.



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PLASTIC CUTOFF FOR SEEPAGE CONTROL

by **K. S. EHRMAN**
Chief, Waterways Design Branch, Columbia Basin Project

EARTH canals and laterals in sidehill locations often need linings for bank safety and seepage control. If irrigation is planned above the canal, a rising water table may create back pressures that could rupture conventional canal linings.

However, where a relatively impervious layer of silt, clay, or rock exists within a reasonable distance below bottom grade, a vertical cutoff wall in the lower bank may provide the required safety and seepage control. Such a condition existed on the Columbia Basin project constructed and presently operated by the U.S. Bureau of Reclamation.

Approximately 5,934 linear feet of vertical plastic membrane cutoffs were constructed along two canals on the Columbia Basin project in March and April of 1963. Work on one canal consisted of installing 2,334 linear feet of 10-mil black polyvinyl chloride sheeting 24 feet wide in a nearly vertical trench to strengthen the canal's lower bank.

On the second canal 3,600 linear feet of two-ply reinforced polyethylene sheeting 12 feet wide was installed in a vertical trench along the lower inside toe of the canal and this was topped by compacted blended earth lining along the inside lower canal bank to reduce seepage. The work on both canals was performed by contract under specifications prepared by the Bureau. The installations were the culmination of experimental work with plastic membrane cutoffs performed on the Boise project in Idaho in 1959, and on the Columbia project in 1962.

Vertical plastic curtain walls of the type installed on the Boise project in the spring of 1959 apeared to offer a low-cost answer to the project needs. Accordingly, in the spring of 1962, a 300-foot experimental test reach was selected on the Columbia Basin project's East Low Canal for installation of a 20-foot-wide plastic membrane. In this reach, leaching and piping over a period of years through intermingled layers and pockets of sand and caliche in and below the canal bank had caused occasional breaks. A plastic membrane cutoff could sever these layers and prevent future canal breaks.

Experimental Installation

The experimental work in 1962 was advertised but the only bid received was rejected as being excessive. Accordingly, the work was accomplished by Government forces. When completed the actual installation covered only approximately 200 feet because of construction problems encountered.

A 300-foot-long by 28-foot-wide strip of 8-mil thick black polyethylene membrane accordian folded was ordered for the work. Upon its arrival, it was discovered that the supplier had substituted 6-mil-thick plastic. Because of time limitations however, this thinner plastic was used and a price adjustment secured from the supplier. Essentially the procedure was to blade a berm or ledge, at an elevation 18 inches above water surface with a dozer; then to excavate a vertical sided trench about 25.5 feet deep and 4.5 feet wide with a 1-cubic-yard dragline. The excavation was into damp sand.

After the plastic was unfolded, loops formed by an adhesive, filament tape were attached along the top edge to hold anchor ropes. This tape sticks very well on clean plastic.

Due to a breakdown of the dragline, it was impossible to finish all 300 feet of trench fast enough to avoid some sloughing or excessive wetting. To minimize this danger, a 100-foot strip of the plastic was suspended from the bank of the first excavated portion of the trench and backfilling began by pushing the material from the canal side into the trench by dozer. Unfortunately a large slough occurred while backfilling was in progress. The sloughing material fell against the plastic and tore it loose from most of its anchors with most of the plastic sheeting falling into the bottom of the trench.

Since safety requirements prohibited entering the trench, the entire reach was backfilled and a new trench re-excavated through it. In spite of some additional sloughing, the remaining 200 feet of plastic was successfully installed. Loose backfill was placed through the intermediate reach; water was added to the backfill at the ends of the trench to make a mixture of thin mud, or slurry, to seal the ends in place. Gravel protection was then placed along the inside slope of the canal.

The Buckeye trencher machine at left has "dug in" to a trench depth of about 10 feet for a cutoff, curtain-laying trial on the Columbia Basin project.

When water was put into the canal at the beginning of the irrigation season, there was some settlement of the loose backfill. However, this consolidation had been expected and the bank was reshaped by operation and maintenance forces when equilibrium was reached. Readings of observation wells during the 1962 irrigation season indicated that the membrane was not only affording protection to the canal banks but was also reducing water loss through the bank. Rise in the wells directly opposite the lined reach was as much as 10 feet less than the rise in wells at either end of the reach.

Total direct construction cost including the plastic and riprap for the successfully installed 200 feet of lining was slightly more than $11 per foot. In spite of the difficulties encountered in making this installation, it was obvious that a successful low-cost side lining could be secured by installing a plastic membrane in a vertical trench.

Second Trial Installation

The success of the first installation in the East Low Canal and the availability of a ladder-type excavator with a shield used for installing draintile in wet and unstable ground suggested a possible solution of a different problem. A portion of irrigable land adjacent to a wasteway could only be drained by pumping into the wasteway, but unfortunately the wasteway was constructed in gravelly materials that would have rapidly recharged the area being pumped. It was decided that if a cutoff wall could be installed to a relatively impervious layer of material which was 6 to 8 feet below ground surface, this recirculation of pumped water would be eliminated.

Project Engineer W. T. Lowe of the Drainage Branch devised a shield to fit the ladder-type excavator so that a vertical roll of plastic up to 12 feet long could be suspended inside the shield and fed out between the rollers at the rear. After a trial run in firm ground, about 1,300 feet of 8-mil polyethylene plastic was installed by the project forces along the wasteway, and although the plastic initially tended to bind in the rollers at the rear of the shield, this difficulty was generally corrected by remodeling the rollers to use washing machine wringer rolls with sealed bearings. The depth of the installed plastic varied from 6 to 10 feet.

West Canal Installation

The success of both the experimental East Low and wasteway installations prompted two more extensive installations during the 1962–63 nonirrigation season. On the West Canal, leakage from one reach about 5,050 feet long was a major contributor to a high water table threatening about

Test curtain installation at the East Low Canal area shows filament tape anchors on the upper edge of the black plastic.

300 acres of land. Full lining of the canal was impracticable because of the size of the canal and because irrigation from higher ground could also contribute to the high water table, so that back pressure could be expected against a full-lined perimeter.

The canal in this reach was excavated in sands, silts, and caliche (lime impregnated sandy silt) with a relatively impervious material at varying depths below grade. The saturated sands were quite unstable. In this situation, it appeared that a vertical plastic cutoff wall along the inside toe of the lower bank plus a side lining of the inside lower bank would form a barrier against the migration of water from the canal and from the lands above the canal into the lower areas.

Accordingly, plans were prepared for the installation of 4,000 square yards of plastic membrane to be placed in the trench to a maximum depth of 12 feet below grade, using the shield and equipment developed for the wasteway installation. The plastic was to be topped by a compacted blended earth side lining. The work was advertised and awarded to a low bidder in the fall of 1962.

The contractor began by excavating for the side lining with a dragline. The canal was dewatered to a point below the canal invert grade by digging a drain trench along the right bottom of the canal and pumping water over a dike at the downstream end. As permitted by the specifications, the contractor decided to use the project-owned shield which would hold a 400-foot roll of plastic. The contractor also leased the same ladder trencher used in the experimental installations, and after completing the side lining excavation, began the installation of the Government-furnished 10-mil polyvinyl chloride sheet.

Some Difficulties

Again difficulties were encountered because of the tendency of the plastic to bind and tear as it emerged from the shield. After some 25 to 30 feet of plastic had been installed and before the full depth of cutoff was reached an equipment breakdown stopped work. During this enforced shutdown period the contractor further modified the shield to improve its operations. These modifications consisted of lengthening the shield, so that a second roll of membrane material could be placed within it; providing a sealed bearing on which to suspend the plastic roll; and installing a pipe for an air jet to keep silt and mud from settling in the bottom of the shield and to insure free turning of the plastic rolls.

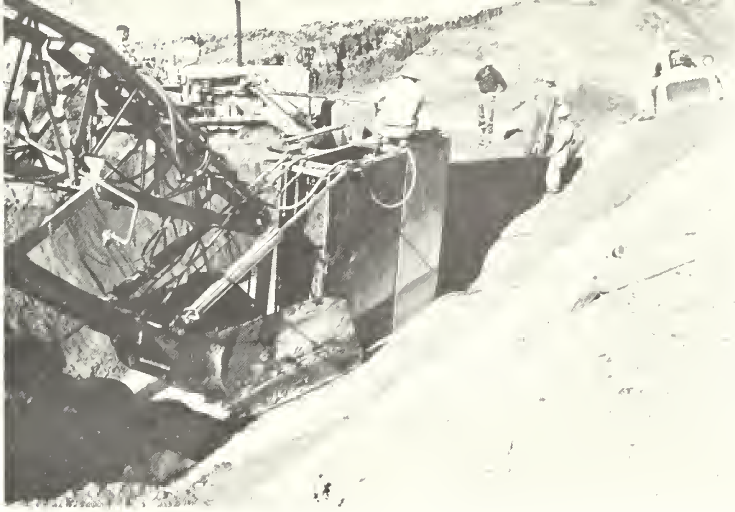
Using the newly modified shield the contractor resumed work and placed 75 feet of plastic. Again some ripping and tearing occurred. In order to use a material with greater resistance to binding and tearing, a substitution of two-ply nylon reinforced polyethylene sheeting was authorized for use.

A further complication was encountered where one reach of the canal was on a curve and where caliche was at or near the canal invert grade. The contractor found that the caliche in this reach could be ripped sufficiently to be excavated, but that the trencher could not be turned on a short enough radius to negotiate the curve. Therefore, the trench in this caliche reach was ripped with a tractor, excavated to a width of 3 feet with a backhoe and refilled with the same blended earth mixture designed for the side lining above the cutoff. The blended earth lining was placed in four short reaches where depth to caliche was a maximum of only 2 feet.

The machine was used, however, to install 2,740 lineal feet of plastic in soft and unstable ground. The depth of the machine-excavated trench varied from about 2 feet to a maximum of 9 feet, which was the greatest depth before caliche was reached. Even in a firm trench the maximum installed depth of plastic is about 10½ feet because of the tendency of the material to slump when backfill was placed against it. In unstable ground about 7.5 to 8 feet was the maximum depth that can be installed using the ladder excavator and shield.

During the winter the sandy upstream reach of the canal that had previously tended to slough dried out sufficiently so that a trench could be excavated to a depth of about 8½ feet with a backhoe. A roll of plastic material was suspended on end in the trench, then unrolled to form a vertical cutoff. After the cutoff was completed, the contractor placed a 1-foot-thick layer of preblended lining material over the membrane-lined trenches before constructing the remainder of the compacted blended earth side lining by conventional methods.

Total contract cost for the West Canal installation including the two-ply plastic was about $19 per linear foot of lining. Readings of observation wells below the canal show much less and slower



Backfilling is in progress in the badly caving sand area at West Canal. Workman in center is holding the plastic curtain as bulldozers push dirt in around it.

buildup of ground water than in previous years. This indicates that plastic curtain is performing its job satisfactorily.

East Low Canal Installation

In the fall of 1962, three separate reaches of the East Low Canal were selected for the installation of vertical plastic membrane side lining. These were reaches where bank stability was questionable. In one of the reaches a canal break had occurred at an apparent low spot in the core bank. Free water was emerging in places along the toe of the bank and there was sufficient moisture within the bank that efflorescence from the evaporation of pore water was occurring on the operating road on top of the bank.

Probes with auger holes and cross trenches in the banks indicated typically silty sand or sandy silt interspersed with streaks of sand and caliche. The original ground below the bank was a low density loess (yellowish-brown, wind-deposited soil) and caliche with occasional lenses of open gravel. The material was considered free draining enough that it could be expected to stand vertically for short periods of time.

Under these conditions a plastic cutoff wall similar to that previously described on the East Low Canal appeared to offer an inexpensive and satisfactory method of repair. Plans were prepared, the work was advertised and awarded to the low bidder. The contractor began work in the upstream reach of the canal excavating the berm with a dozer and the trench with a dragline.

The 10-mil polyvinyl chloride sheeting was furnished to the contractor, accordian folded in 250-foot-long sheets. Renting hangar space at the Ephrata, Washington Airport, the contractor unfolded the plastic and rolled it around a pipe spindle. The plastic was placed in the trench by suspending the roll vertically from a second dragline and it was then unrolled like a new carpet as excavation proceeded.

The method of installation proved fast and efficient and kept the plastic close behind the excavation so the danger of trench sloughing before the plastic was put in its place was kept to a minimum. Backfilling followed as closely behind the plastic installation as possible. After completing the trench and berm backfill, a gravel beach belt was placed on the inside slope of the lower canal bank.

Except for some minor sloughing when too much trench was opened up on too steep a slope, work was completed on this reach of cutoff without incident. The contractor reported some holes or voids in or below the bank during excavation. When the canal was primed at the beginning of the 1963 irrigation season there was some settlement over the work area but this had been expected. The bank was dressed up by project forces after settlement had stopped.

Total construction cost including Government-furnished plastic membrane for this plastic curtain job was about $9.65 per linear foot.

# # #

(This article by Mr. Ehrman appeared under the title: "Vertical Plastic Cutoff," in the "Operation and Maintenance Equipment and Procedures Release No. 46," and under the title: "Plastic Surgery for Irrigation Arteries," in the March 1964 Journal of the Construction Division of the ASCE.)

A New Look at . . . THE IDAHO GEMS

by HAROLD L. MATHES *and* W. DEAN BOYLE
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Region 1, Boise, Idaho

"KING of the Gem State," is the noted Idaho Russet potato, also known as the "Netted Gem." The qualities of this Gem are attested to not only by Idahoans, but also by consumers throughout the world.

The State of Idaho is endowed with natural resources and climatic conditions rarely found in one area, and Idaho potato farmers have the technological knowledge and facilities to combine these elements into a superior, soil-born creation. This potato country has the natural advantages for quality production, such as the relatively high elevation, the nutrient rich volcanic soils, warm days and cool nights, and a stable supply of mountain snow water for irrigation.

By applying up-to-date management practices with the favors from Mother Nature, the grower has been able to produce and deliver a consistently superior crop to local and national markets from year to year. This has been accomplished by combining the use of disease-free seed, judicious fertilization, improved harvesting methods, scientific handling and storage, and controlled temperature and moisture through irrigation.

Without the lifegiving supplies of water furnished through vast and intricate irrigation facilities, there would be little produced from the arid earth of southern Idaho, especially the noted potato. This water and the necessary regulating and conveying systems have been provided through the efforts of private development and Federal Reclamation projects as a means of reclaiming vast acreages of desert lands.

The Idaho potato industry has been soundly developed through the support of the universities, processors, packers, shippers, and associated service organizations, and through potato education and promotion programs. Federal and State research centers also continually serve the industry.

As might be expected, while potato production was pushed higher and higher, the buying and eating habits of the American family changed. World War II and its demand for concentrated, packaged potatoes, followed by the market for a convenient ready-to-heat-and-serve product, and the vanishing family storage pit, all contributed to an increasing popularity for processed potatoes.

Leading State

In the 1950's, changes in utilization, marketing, and processing contributed significantly to making Idaho the leading State in the production of potatoes, in the shipment of fresh potatoes, and in potato processing.

In 1954, there were 153,900 acres harvested by the Idaho potato farmer. This acreage increased to a high of 273,800 acres by 1961. Of the 244,500 acres harvested in 1963, Federal Reclamation projects supplied irrigation water to 58 percent of the lands. When it was discovered in the 1950's that there was a tremendous supply of underground water in lands of the Snake River Valley, new acres of desert were developed to augment potato growing.

Production Impact

Although yields per acre fluctuate, the trend continues upward. The increase in average yield to 227 hundredweights has been mainly responsible for the large 1963 crop of 55,450,000 hundredweights, about doubling the 1954 production of 26,624,700. Total value of the 1963 production was estimated at $68 million.

Much of the increase in potato acreage is due to the dynamic growth of potato processing.

Twenty years ago, Idaho had two or three small potato processing plants, of which two processed potato flour and one manufactured dehydrated potatoes. In 1950, less than 5 percent of the potato harvest was processed. Today, over 40 percent of the Idaho crop is made into food products. This includes freezing, dehydration, canning, chips, and flour. If starch is included, the utilization for processing is nearly 50 percent. It has been predicted that this percentage will climb to 85 percent in the next 40 years. Idaho potato processors, plus the processing industry located in nearby Malheur County, Oreg., manufactured 62 percent of all frozen and dehydrated potato products shipped for consumption in the United States during 1962.

Other gains in processing have been noted in recent years. Twelve Idaho companies operating eighteen processing plants are marketing more than thirty different frozen or dehydrated potato products used by the American consumer. Total 1962 plant investment was nearly $42 million, a sevenfold increase in 12 years, and a spectacular jump of $12 million in the 1960–62 period. New employment has risen by 6,400 from 1950 to 1962. Employee wages by 1962 totaled more than $21 million, a 1,000 percent increase over 1950. During 1962, the city, county, and State taxes paid by Idaho processors amounted to $1.3 million.

One fully integrated company in Idaho grows much of its raw potato supply, ships fresh potatoes, prepares dehydrated and frozen products, makes starch, and feeds the left-over wastes to about 50,000 head of cattle. This large scale operation requires an electric power supply equal to that needed by a city of 15,000, and a water supply equivalent to that for a city of 70,000 people. A year's production of finished products by this company would provide potatoes for one meal for 8 billion people.

Preparation for Drying and Freezing

When visiting one of these modern processing plants, the tourist, and for that matter, many an Idahoan, stands in amazement at the sight of the never ending streams of shining white potatoes on their way to become hash browns, french fries, instant mash, and the numerous other delicious table products. Beginning with mammoth storage cellars which preserve the natural flavor and cooking qualities of the Idaho Russet, these processing plants wash, remove skins, and convey these shining white tubers past hundreds of skilled employees. These employees sort for size and trim for quality, leaving only unblemished gems for slicing and blanching in further preparation for drying or freezing.

An inspector checks them as they are conveyed from the peeling operation.

Efficiency and sanitation are important at this large-scale plant. **(Photo, courtesy of the J. R. Simplot Co.)**

Variety of Products

The major Idaho frozen potato product is frozen french fries. In many convenient forms—such as slim cut, shoestring, regular and crinkle cuts—the frozen french fries are available to the American table in any season of the year. Other frozen items consist of shredded Idahos formed into all-purpose chunks, patties, puffs, hash browns of various portions, diced potatoes, stuffed bakers, shreds and chunks for mashed potatoes, and other specialty products. Frozen patties and hash browns are produced with or without onion flavor. Well known trade names for frozen shredded products ready to heat and serve, for example, are "Tater Tots," "Gems," and "Nuggets."

Dehydrated products include instant mashed potatoes—created from either granules or flakes—diced, riced, sliced, au gratin, and scalloped potatoes; chiplets, potato mix for pancakes, and many other dehydrated food items. Processing of granules (powder form) include the initial cooking, then mashing and drying to a very low water content, after which the granules are packaged, shipped, or stored. Flakelets are created by feeding the cooked and mashed potatoes into a drum drier where they are steam dried, flaked off, and then sized and packaged.

Combining the advantages of freezing and dehydration a new process "Dehydrofreezing" has been developed. This process removes nearly half the water content of mashed or diced potatoes before the product is frozen. The new process saves space and shipping weight, and retains the flavor, color, and texture qualities inherent in Idaho potatoes.

Current estimates indicate that about 10 percent of the Idaho potato crop is processed into starch. The starch industry provides a market to the farmer for potatoes of any size or shape, including culls. Paper, textile, mining, food, and adhesive industries require potato starch in their operations.

Market Changes

Although shipments of fresh potatoes have dropped from a peak of 50,000 cars to current

annual fresh shipments in excess of 30,000 cars many consumers still prefer fresh potatoes for certain table uses. The popularity of Idaho baked potatoes continues unchallenged.

Reflecting the changes in marketing and merchandising, an increasing proportion of the fresh potatoes are packaged for buyer appeal before reaching the retail market.

The U.S. housewife has sharply increased her purchases of frozen potato products in recent years, although restaurants, hotels, and other large food servers comprising the institutional market currently show an even larger usage. However, since the retail market is nearly four times the size of the institutional market, most observers feel that the retail market offers the greatest potential for expanding sales of frozen and dehydrated potatoes. Another market of great potential is the export of dehydrated mashed potatoes to foreign countries. With the rapid development of facilities for handling frozen foods in foreign retail channels, there may be promising opportunities for marketing frozen potato foods.

Optimistic Outlook

As a result of the expanding U.S. population, there will be about 20 million more people to consume both fresh and processed potatoes by 1975. This will benefit grower, shipper, processor, and associated businesses with the grower and processor appearing to have the advantage. It is believed that the processing industry has not reached the limit of its market outlets, especially the retail, and the potential appears boundless. Idaho's potato processing industry may be stabilizing or reaching its maturity, but it is still highly competitive and growing.

With the emphasis on placing the highest quality product on American dining tables, the long run prospect of the potato industry is one of optimism. And with Idaho's ability to produce superior potatoes in immense quantities and to process them into the forms that the ultimate consumer wants, the potato is *King* in Idaho and seems destined for a long, progressive reign. # # #

A refrigerated train car is being loaded with processed potatoes for shipment.

A Possible Pest on Ditchbanks

NUTRIA

by **DR. RICHARD H. MANVILLE**
Branch of Wildlife Research,
Bureau of Sport Fisheries and Wildlife

EDITOR'S NOTE: It has come to the attention of the Bureau that nutria burrows have seriously damaged dikes, bayou banks, drainage canals and irrigation ditches. The map in the accompanying article indicates that the animal has been reported in 14 of the 17 continental Western States. Irrigation districts are advised of the potential danger of nutria and are requested to report finding of them to the Bureau of Reclamation.

California Department of Fish and Game indicates that nutria have been imported into the State by fur farmers and some have escaped. Muskrat trappers have taken them at widely scattered points throughout California in the past 10 years. However, they have not been reported thriving up to this time.

Clean ditch maintenance plus the lack of their preferred vegetation, seems to militate against their becoming established. The Department of Fish and Game is alert to their potential as pests and State law requires that they be kept in pens.

A reprint follows of the text of Wildlife Leaflet 445, August 1962, reissued April 1963, entitled: "The Nutria in the United States," by Dr. Manville.

IN the last few decades a native South American mammal, the nutria or coypu (*Myocastor coypus*), has become widely established in the United States. For a time it was regarded as a desirable furbearer, but it soon became evident that it might become as distinct a liability as the introduced starling and house rat. Interest in the nutria has increased in recent years. Encouraged by the claims of commercial promoters, many people have investigated possibilities of raising nutria as a profitable venture; most of them have been disillusioned.

Natural History

The nutria is a large aquatic rodent that rarely attains a weight of 25 pounds. Superficially it resembles a muskrat, with reddish-brown fur, a long rounded tail, and hind feet that are partially webbed. The family is raised, and may persist as a colony, in bank burrows or in platform nests anchored to marsh vegetation or built up from the bottom.

The nutria is prolific; a female may have five litters in 2 years, at any season. The young number from two to eight (average five) per litter. Females first breed successfully at about 1 year of age. The gestation period is about 130 days. The young are well-developed at birth and get about on their own in a few hours. By their second week they begin to eat solid food, and they are weaned by the eighth week.

In its feeding habits the nutria is strictly herbivorous. Its natural foods include a variety of aquatic plants—succulent green stems, rushes, grasses, seeds, roots, and such coarse vegetation as cattails, reeds, duckpotato, chufa roots, and sedges. The food is usually consumed on the shore, particularly in the evening.

In the United States

In 1850, nutrias were abundant in the rivers, estuaries, and marshes of their native Argentina. Changing fashions and requirements of the fur trade, to the point where the demand for pelts was 100 times that of the supply available from hunters and trappers, nearly led to their extermination. Raising nutrias in capitivity began in South America in 1922, farms sprang up throughout Argentina, and the industry spread to Europe and North America. Nutria farms were established in Quebec, Canada (1931), in the Green

River area of the State of Washington (1932), on Avery Island, Iberia Parish, La. (1938), and elsewhere. In most cases these proved to be costly investments, since more money was spent on equipment, feed, and labor than was realized from the sale of furs. Most nutria farms went out of business; many operators turned the animals loose or allowed them to escape. From these releases the nutria has spread and become widely established over the country. Feral nutrias have been reported from at least 31 States and 3 Canadian Provinces; established colonies apparently exist in the wild in at least 16 States.

Economic Importance

As is often true of newly established foreign species, the nutria population has built up rapidly in some areas. Breeding at the rate it does, an animal of this size and with its voracious appetite can pose a serious problem. Competition with native wildlife is one result—muskrats have declined in areas when nutrias were on the increase. Habitats have been altered and waterfowl marshes destroyed. In agricultural areas, nutria burrows have seriously damaged dikes, bayou banks, drainage canals, and irrigation ditches. Cultivated crops have been ruined on sites close to waterways. Alfalfa, sugarcane, rice, and young corn seem particularly subject to attack, and the nutria also has a taste for such produce as sweetpotatoes, cabbage, clover, and most root crops except white potatoes.

These damage problems are at present most intense in parts of Louisiana and Texas. Both State and Federal Governments are doing reseach and expending funds on control of the nutria where it is established in the wild and is proving detrimental to other interests.

Wild Nutria Catch in Recent Years

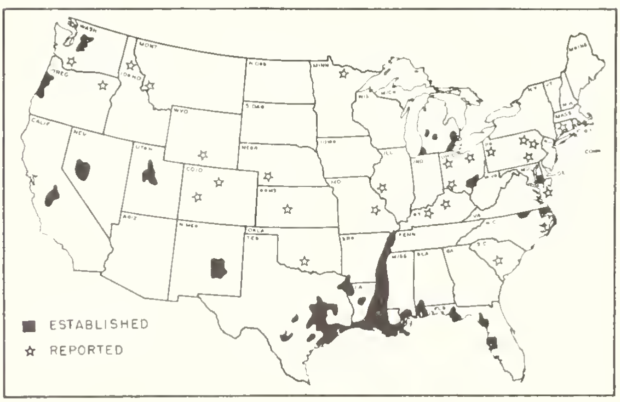
	1960	1961
Arkansas	----------	10
Florida	----------	1
Idaho	31	5
Louisiana	694, 110	716, 435
Maryland	34	----------
Mississippi	----------	384
North Carolina	536	36
Oregon	154	547
Texas	270	13, 402
Virginia	74	92
Total	695, 209	730, 912

Nutria as a Fur Crop

Nutrias are trapped in the same manner as are the smaller muskrats, except that the traps must be staked out more securely. The pelt is "cased" and dried, fur side in, over a frame 30 to 35 inches long. The condition, quality, and color of the under-fur determine the price received. There is practically no commercial demand for pelts less than 22 inches from the eyehole to the bottom of the skin. Because of the extra work required to prepare nutria, many Louisiana trappers prefer to concentrate on muskrats. In recent years the best wild-caught Louisiana nutrias have brought \$2.50 a pelt; the average has been about \$1. Over 80 percent of these raw furs have been exported to the European markets. The few low-grade skins consumed in the United States have been used principally for linings in cloth coats. Even the best nutria garment is far less serviceable than fur seal, beaver, or sheared raccoon. It is the high processing and manufacturing costs that make the finished nutria fur coat a luxury item.

Ranch-raised nutria pelts produced in the United States have not been significantly superior to the best grade of South American or Louisiana wild nutria. Prices for these pelts have been disappointing, owing to the inferior size and quality of the skins. By 1940, most American ranchers had gone out of business. Those that continued operated mainly as centers of distribution, holding wild-caught animals for exportation as breeding stock.

(Continued on page 74)



A Demonstration on Farming

EDUCATIONAL IRRIGATION

RAPID and complete farm development is the secret of success in today's changing irrigation farming economy. This may be plain to all, yet today's mechanized agriculture demands management techniques far advanced from the days when manpower was plentiful. In order to keep abreast with this change, the Bureau of Reclamation, and other agencies, have accepted the challenge to find better and more effective ways of assisting the new irrigator in wisely developing his resources.

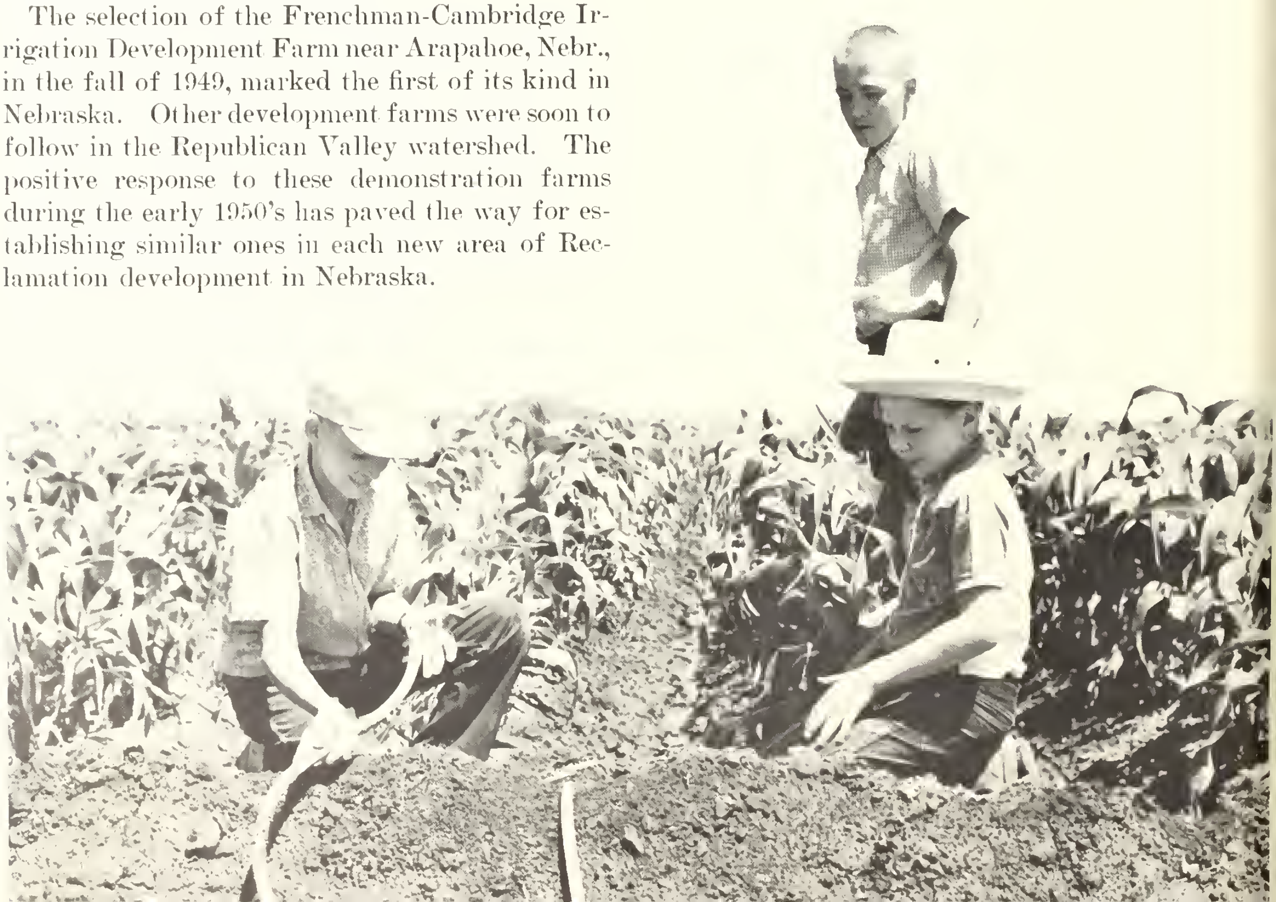
Representatives of several Federal and State agencies sharing a common interest in irrigation, met in Nebraska in May 1947. During this meeting a general agreement was reached for a coordinated educational program. In September 1949, at a meeting called by the Republican Valley Conservation Association, a mutual agreement, in the form of a Memorandum of Understanding, was negotiated to establish development farms and thereby coordinate educational demonstrations of approved irrigation practices.

The selection of the Frenchman-Cambridge Irrigation Development Farm near Arapahoe, Nebr., in the fall of 1949, marked the first of its kind in Nebraska. Other development farms were soon to follow in the Republican Valley watershed. The positive response to these demonstration farms during the early 1950's has paved the way for establishing similar ones in each new area of Reclamation development in Nebraska.

Management and supervision of development farms in Nebraska are directed by a State advisory committee composed of one administrative officer from each of the cooperating agencies. Represented on this committee are the Bureau of Reclamation, the Soil Conservation Service, the Agriculture Research Service, and the University of Nebraska. In turn, this committee appoints a State technical committee from interested Federal, State, and local agencies.

The technical committee is charged with the responsibility of selecting each development farm and preparing and administering each corresponding annual farm plan, subject to the advisory committee's approval. In carrying out these responsibilities the technical committee works through its district's extension irrigationist, and the development farm field committee.

Even the younger set—young Donald Gorecki (lower right) and two of this friends—learn to set siphon tubes.



The Bureau's Role

The Bureau's primary role as a member of the advisory and technical committees is to provide assistance in demonstrating approved irrigation practices, and therefore, promote more rapid development. However, as a member of these committees, the Bureau also cooperates with the objectives of other agencies on approved techniques for land preparation, balanced crop and livestock programs, farm organization, and the testing and evaluation of new farm management practices, to mention a few.

In October 1960, a field committee set about choosing a development farm site in central Nebraska on the Farwell Unit of the Missouri River Basin project. In a few months, the Gorecki farm, located about 4 miles northwest of Farwell, was selected.

This choice was based on landowner willingness and cooperation, as well as the farm's size and location, topographic and soil conditions, and resources for farm enterprises. The farm had representative conditions of the majority of farms to be served in the project area and the potential for developing irrigation.

The Gorecki farm contains 200 acres of land of which 80 acres have been planned for irrigation development. The remaining 120 acres consist principally of native pasture—too steep and irregular for practical irrigation development—and Bureau right-of-way, farmstead, and shelterbelts.

By accepting the position of development farm cooperator, Paul Gorecki was mainly responsible for management and operation. Mr. Gorecki's experience also was utilized in performing other duties, as set forth in each annual farm plan. In accordance with the latest designs as prepared by technicians representing the technical committee, he performs both land and irrigation operations. The farm is accessible for educational purposes, tours, and demonstrations that are approved by the technical committee.

Gorecki also agreed to keep financial records of production and development assisted by the district extension irrigationist, who also was available for helping determine time, amount, and frequency of water application.

Specifically, the State technical committee agreed to furnish the following:

1. Plans and assistance for the design and layout of field grading, ditches, and irrigation structures.
2. Recommendations on crop varieties, cultural practices, and weed and insect control.
3. Commercial fertilizer, seed, labor, equipment and any other materials necessary to conduct special field studies, investigations, or demonstrations—planned not to interfere with normal farming operations.
4. Such farm equipment as is required in excess of that considered adequate for farming under normal irrigation development conditions.
5. Reasonably good access roads required for special studies and tours, considered outside normal farming operations. Included, on a loan basis, are such items as cattle gates and culverts needed for easy access by the public.

An Experienced Farmer

Paul Gorecki was reared on a farm only 1½ miles southeast of the farm he now owns. He has devoted his life to farming and received his first experience with irrigation in the central Platte Valley. Paul and his wife Rita began renting their present farm in 1950 and became its owners in 1957. Their two children, Margaret, 15, and Donald, 11, attend school at Farwell. All members of the Gorecki family have been instrumental in farm improvement by working together as a family unit to achieve their common goal. This attitude of farm family cooperation is important for success in a new area of irrigation development. Paul works closely with his father and two brothers Raymond and Edwin who own irrigation farms nearby. They exchange machinery and labor to economize operating expenses.

Deeply dissected by large drainageways, the farm land has changes in elevation of from 35 to 45 feet between the lowest areas of depression and the adjacent irrigable lands. The bulk of the more desirable land is located in the northern part of the farm.

Irrigation development began in 1961, 2 full years prior to initial water delivery. Land leveling that year was limited to 19.5 acres in fields 3 and 12 as depicted on the farm diagram. Disposal of excess irrigation and rain water was considered to be of prime importance, because of the erosion-prone characteristics of drainageways.

Considerably more land was leveled in 1962 to prepare the farm for the next year's water delivery. Also, Paul constructed six concrete drop structures along farm laterals to provide for easier water control. These structures were made from an approved SCS design.

Other Structures

In July 1962, a small retention dam was built with construction costs shared by Mr. Gorecki and the Federal Government under the provisions of the Great Plains Program. Also, the farm access road was elevated and graded to promote drainage and to provide a better road for the increasing number of visitors. Field tests to determine water intake rates were performed in field 2 on which alfalfa had been growing for 4 consecutive years.

In 1963, more land was field leveled, bringing the total of all developed land to a little more than 57 acres, fields were sown to grass, and additional irrigation structures were built.

Itemized development costs including conservation program cost-share payments on the Gorecki farm through 1963 are as follows:

Land leveling	$5, 574
Waterway shaping and seeding	187
Field drain shaping	24
Lateral siphon	352
Retention dam	1, 124
Access road grading	150
Concrete drops	600
Road crossing and control gate	172
Native grass seeding	433
Total	8, 616

The Gorecki farm is an example of well-balanced crop and livestock resources. All crops except wheat are marketed through livestock. Paul manages 20 to 25 head of shorthorn cattle in addition to his hog production enterprise of 25 to 30 litters farrowed yearly. Both cattle and hogs are marketed in fat and feeder condition, the proportion depending entirely upon seasonal feed grain and roughage yields and market conditions.

It is anticipated that irrigation not only will increase the potential, but also will help to stabilize livestock production from one year to the next. Expansion of hog production is expected as the production of feed grains is increased. Some cream sales are made, but they do not contribute significantly to the farm income. Mr. Gorecki supplements his own crop production by renting a quarter section of nonirrigated cropland on a share basis.

In anticipation of receiving irrigation water in 1963, Mr. Gorecki drilled fall rye, fall wheat, sewed mixtures of bromegrass, orchardgrass, reed canary, ranger alfalfa, and ladino clover and made various test applications of fertilizer.

Seedbed preparations for corn planting were completed by the last week in April, but unseasonably dry weather during the late winter and early spring months resulted in inadequate soil moisture to allow complete germination. In view of these circumstances, he decided to delay corn planting until rain replenished the soil moisture.

First Farwell Water

June 19, 1963, marked the first water delivery on the Farwell Irrigation Development farm, and likewise, the initial water delivery from any Farwell project facilities. Gorecki was adequately assisted that day by his son, Donald; his two brothers, and the extension irrigationist, John F. Decker.

The farm's irrigation activities for 1963 are summarized as follows:

	Acres irrigated	Number of irrigations	Total water applied in acre-inches
Corn	46. 9	4	23. 4
Grain sorghum	8. 5	4	30. 0
Irrigated pasture	1. 5	2	14. 7
Fall rye	6. 7	1	5. 3
Total	63. 6		[1] 22. 2

[1] Average.

The lack of rain during the growing season took its toll over the entire project area during this first year of irrigation. Significant differences in dry land and irrigated farm yields were quite evident since project water was available to only slightly more than 3,300 acres of land. Much of Paul's seedling grasses in field 8A were lost before they could be irrigated. He reseeded the new pasture prior to the second irrigation in an attempt to improve the stand. No yield was obtained from it that year. For that matter, yields from established nonirrigated native pasture land were negligible also. Two other nonirrigated

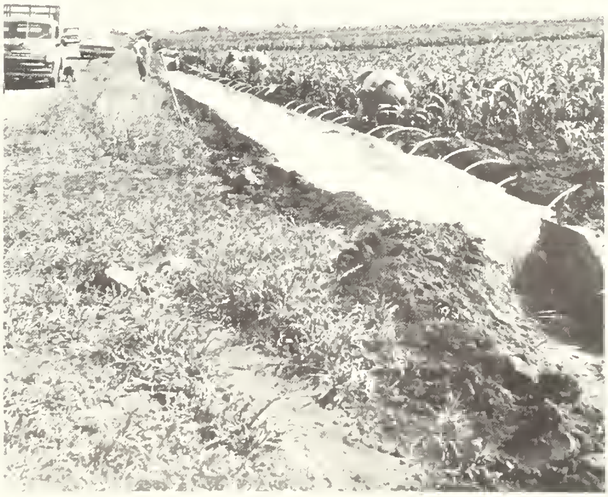
crops, wheat and barley, yielded only 6.3 and 8.0 bushels per acre, respectively.

Mr. Gorecki's irrigated corn yields ranged from a low of 80 to a high of 120 bushels per acre, with an average 1963 per-acre yield of 95 bushels. His grain sorghum yields averaged 80 bushels per acre. By comparison, the average 1963 per-acre yield of irrigated corn in Howard County was 13 bushels less than that raised on the Farwell Development farm. Mr. Gorecki topped the average nonirrigated corn yield for the county by some 70 bushels per acre in this same year. Correspondingly, his grain sorghum yield equaled the average for that under irrigation in the county and was 45 bushels greater than that not irrigated. This wide variance shows the benefits of irrigation in this area.

Among the more important aspects of irrigation development farms in Nebraska are the field studies conducted to develop the most efficient farm practices and to demonstrate the findings to project settlers. Such studies are usually initiated by the University of Nebraska Extension Service and are performed under the direct supervision of the district extension irrigationist. Many local merchants and businessmen have generously donated seed, fertilizer, and other necessary materials for these studies. Four different field tests were performed on the Gorecki farm in 1963, with the cooperation of the operator.

Numerous tours of the Farwell irrigation development farm have been conducted since 1962. In 1963 an estimated 1,500 persons came to learn and perhaps adopt some of the new farm practices they saw demonstrated. With the good management of the Gorecki farm family and with the help of the cooperating agencies, the development farm will continue its irrigation education for all visitors—especially for neighborhood farmers on Reclamation's Farwell unit. # # #

Using siphon tubes for irrigating the corn field is one of the operations demonstrated on the development farm.



KEEPING A PROJECT IN SHAPE

by ROYCE VAN CUREN
Boise, Idaho

EDITOR'S NOTE: The Bureau of Reclamation today is realizing the benefits of the 15-year-old Review of Maintenance Program serving projects operated by the water users and the Bureau. In the last issue of the *Reclamation Era*, the article, "A Stitch In Time . . . ." describes the Bureau-wide program as administered by the Office of the Chief Engineer, Denver, Colo. S. T. Larsen, Chief of the Bureau's Maintenance Engineering Branch, is author.

In this article, the Boise project's outstanding example of regular examination of irrigation facilities in west-central Idaho, supplements the information in Mr. Larsen's article.

Illustrating both articles are photographs taken of an inspection team on a recent tour.

Comments follow describing how the maintenance and inspection program is conducted in cooperation with the Bureau, for facilities in the Boise project water user organization.

Mr. Van Curen is manager of the Boise Project Board of Control.

"THE farmers have been responsible for the operation of the project since the approval of construction repayment contracts in 1926. At that time the project was divided into five irrigation districts who joined together to constitute a board of control. Representation to the board of control comes from each district on a per acre basis, giving each district an equal voice (per acre) in management and operation.

"Operation and maintenance charges are fixed by the board of control and passed back to the districts who are the collection agencies. All operating and maintenance charges are set uniformly so that each district or individual within the district has the same charge per acre.

"The board of control is the operating agency on the project for the five districts, with each district furnishing its proportionate share of the operating and maintenance costs.

"The operating forces consist of a manager, assistant manager, secretary-treasurer, and office personnel in the main office in Boise. Four watermasters' divisions with offices in the field are strategically located for smooth operation of 139,000 acres of the project with the balance of the Government-constructed facilities operated by one of the five districts along with some of its own non-Government irrigation. Operating forces of the board of control average close to 100 permanent year-around employees.

"The need for a sound budget is a foregone conclusion and the only possible way to arrive at good budgeting is periodic inspection and study. A 50-year-old project definitely will have maintenance problems and it is essential that all facilities be checked as part of a comprehensive preventive maintenance rotation program.

"Replacement of structures and rehabilitation of canals and laterals are two important items that have to be carefully fitted into each year's schedule. A number of less important items have to be studied and tailored to sandwich in with the more important work. The biggest problem is to be farseeing enough to keep ahead of a possible pileup of work that will all have to be done in only a year or two.

Floodgate works which are used to regulate flows into Lake Lowell from Feeder Canal are being examined by the group.

Inspection Each Year

"In order that the board of control might keep up the proper pace in operation and maintenance activities, a project-wide inspection each year is essential. That inspection should bring all of the board of control members, district directors, interested farmers, together over a common idea. Bureau of Reclamation representatives participate in these examinations on a biennial basis as a part of the Bureau's Review of Maintenance program.

"The inspection should be well planned to allow time for thorough examination. But not so much time that interest can lag. Scheduling of stops on the tour should be tested prior to the actual inspection so that a fairly exact timetable might be maintained.

"Information and explanation concerning each stop should be written up and copied for each inspector's benefit to speed along any discussion at each stop point. Following the inspection, a good report should be made with all the future work anticipated and as much as is possible, classified as to the time when it should be completed. Work should then be scheduled in an orderly fashion with particular attention being paid to balancing the amount of work for each year.

"Future inspections should then show whether or not the maintenance and operation program is ample and enough funds budgeted. If the project has not these problems, the inspection is very much in order just to familiarize the district directors with current operation procedures and problems.

The author, Mr. Van Curen (with no hat), is shown explaining the flowmeter measuring device to the irrigationists grouped around water transport equipment.

"A good deal of time and effort should be expended in inspection of irrigation works by the people concerned with future operations in order to always keep the project in sound operating shape.

"Irrigation works involve a considerable investment, and inspection tends to provide insurance toward a continual operation." # # #

They observe this lateral being lined with precast concrete blocks which will be sealed with mastic. The bottom was later lined with a conventional concrete mix.

Royce Van Curen

Mr. Van Curen was born and raised in the Boise Valley, where he has spent practically his entire life working with irrigation. He first worked on the Boise project during the summers, beginning in 1937. Following military service during World War II, he returned to work as field clerk for the Boise Project Board of Control. He became watermaster for the Lake Lowell area in 1956 and in 1958 he moved to Boise to become assistant project manager under Forrest Sower. Following the death of Mr. Sower in 1959, he moved up to the position he now holds as project manager.

COMMISSIONER DOMINY RECEIVES 30-YEAR PIN; IS ELECTED AFFILIATE MEMBER OF ASCE

Secretary of the Interior Stewart L. Udall presented a 30-year Federal service pin to Commissioner Dominy on May 25. Commenting on the Commissioner's Federal service, Secretary Udall said: "There are many outstanding men who have served as Commissioner of Reclamation. Their names are engraved prominently on large dams and other engineering structures in the West. But when the record is finally written, there will be none who has done any better than Floyd E. Dominy."

The Commissioner also recently was elected an Affiliate Member of the American Society of Civil Engineers. This grade of membership is for individuals who have attained positions in special pursuits and cooperate in the advancement of professional knowledge and practice. His affiliation with the ASCE is in recognition of the advancements made and the aggressive approach he has instituted in the solution of scientific and engineering problems in water resource development.

WILLIAM I. PALMER RESIGNS TO ACCEPT SENATORIAL STAFF ASSIGNMENT

A career veteran of more than 29 years of Federal service, and an Assistant Commissioner on Commissioner Floyd E. Dominy's original "front office" staff since June of 1959, William I. Palmer resigned effective May 2 to join the staff of Senator Carl Hayden of Arizona as a water resource specialist.

Mr. Palmer has been with the Bureau since 1944. On June 15, 1959, he was named Assistant Commissioner for Project Planning and Irrigation. Since early this year he has acted in the newly created position of Assistant Commissioner—Legislation and Coordination.

Nutria—A Possible Pest
(Continued from page 67)

A Word of Warning

In recent years, promoters of nutria breeding stock have made fantastic claims and have painted rosy pictures of quick and easy riches from the stock they provide. Breeding pairs, claimed as being superior animals of pedigreed stock, have been foisted upon a gullible public at $1,200 a pair. As a result of one such operation, three promoters of a nutria breeders association were indicted for mail fraud in the U.S. District Court, Los Angeles, in 1961. They pleaded *nolo contendere* and were duly fined. Postal officials estimated that this breeding-stock scheme had grossed over $3 million. The association represented has since filed a petition in bankruptcy.

Persons interested in raising nutria as a business venture should consult the National Better Business Bureau, Inc., 230 Park Avenue, New York, N.Y., for current information.

Some States have adopted regulations with respect to importing, rearing, and releasing nutrias. Contact your State conservation or wildlife agency before embarking on a nutria project. # # #

Region 2 in Pictures . . .

(This region includes the northern two-thirds of both California and Nevada.)

Skiers are numerous around the resort buildings of Squaw Valley, California, where the depth of snow averages 450 inches yearly.

Photographed in late evening, the sunset picture shows glistening water in front of Trinity mountains near Trinity Dam, Calif. (Photos by A. G. D'Alessandro.)

MAJOR RECENT CONTRACT AWARDS

Specification No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DS-6036	Missouri River Basin, N. Dak.-S. Dak.	Apr. 15	Two 33,333-kva trailer-mounted mobile autotransformers for Region 6. (Negotiated contract.)	Westinghouse Electric Corp., Denver, Colo.	$296,632
DC-6053	Missouri River Basin, Mont.	Apr. 7	Construction of Yellowtail afterbay dam	Foley Brothers, Inc., St. Paul, Minn.	2,415,378
DC-6155	Weber Basin, Utah	Apr. 6	Construction of East Canyon dam	E-W Construction Co. and L. D. Shilling Co., Inc., Cresswell, Oreg.	2,014,054
DC-6064	Emery County, Utah	Apr. 30	Construction of 3.2 miles of Cottonwood Creek-Huntington canal and Swasey diversion dam.	R. A. Heintz Construction Co., Portland, Oreg.	645,610
DC-6065	Missouri River Basin, Iowa-Mo.	May 5	Construction of the 59.3-mile Creston-Maryville 161-kv transmission line.	L.O.Brayton and Co., Dyersburg, Tenn.	798,712
DC-6066	Missouri River Basin, Nebr.	Apr. 20	Construction of Stegall substation, stage 01	Donovan Construction Co., St. Paul, Minn.	1,229,290
DC-6070	San Juan-Chama, N.Mex.	Apr. 22	Construction of the 13-mile Azotea tunnel with circular section, and appurtenant structures, Schedule 2.	Gibbons and Reed Co., Boyles Brothers Drilling Co., and Dugan Graham Co., Inc., Salt Lake City, Utah.	13,791,000
DS-6071	Central Valley, Calif	Apr. 1	Thirty-six stoplog sections, one lifting beam, and one lot of stoplog seats and guides for intake at Mile 18 pumping plant.	Bannock Steel Corp., Boise, Idaho.	119,276
DC-6075	do	Apr. 20	Riprap protection of the Sacramento River and construction of an earthfill dike and channel improvement for Red Bluff diversion dam, Schedule 2.	Joseph W. Richards, Rio Vista, Calif.	183,218
DC-6077	Navajo Indian Irrigation, N. Mex.	May 1	Construction of Main canal headworks and the 2-mile Tunnel No. 1, tunnel having either horseshoe or circular section, Schedule 3.	Fenix and Scisson, Inc., Tulsa, Okla.	5,402,994
DC-6078	Missouri River Basin, Nebr.	May 1	Construction of Deer Station pumping plant	Bushman Construction Co., St. Joseph, Mo.	175,176
DC-6080	Central Valley, Calif	May 5	Construction of Los Banos Creek detention dam	Guy F. Atkinson Co., South San Francisco, Calif.	3,556,955
DS-6081	Colorado River Storage, Colo.	June 10	Two governors for hydraulic turbines for Murrow Point powerplant.	Woodward Governor Co., Rockford, Ill.	107,400
DC-6082	Columbia Basin, Wash	May 14	Construction of 13.6 miles of blended earth lined laterals and 20.2 miles of concrete lined laterals for Block 81—Part 2 laterals and wasteways, West canal laterals.	Sandkay Construction Co., Inc., Ephrata, Wash.	1,377,417
DC-6083	Missouri River Basin, Mont.	May 13	One 90-ton gantry crane for Yellowtail dam	Broadline Co., Richmond, Calif.	133,702
DS-6088	Central Valley, Calif	May 21	Four hoists for 17.5-foot by 22.89-foot roller mounted gates for outlet works at San Luis dam.	Yuba Mfg. Division, by and through Frank T. Andrews, Trustee of Yuba Consolidated Industries, Inc., San Francisco, Calif.	250,820
DC-6089	Missouri River Basin, Wyo.	May 13	Constructing a protective roof structure for approach area at Fremont Canyon powerplant.	Etlin Peterson Construction Co., Casper, Wyo.	170,608
DC-6090	Colorado River Storage, Ariz.	June 5	Construction of the 114-mile Flagstaff-Pinnacle Peak 345-kv transmission line No. 2.	Meva Corp., Fullerton, Calif	6,132,587
DC-6092	Columbia Basin, Wash	June 2	Construction of Low Gap pumping plant, switchyard, and pump discharge line; and furnishing and installing six additional pumping units in Frenchman Hills pumping plant.	Alton V. Phillips Co., Seattle, Wash.	769,734
DC-6094	Missouri River Basin, Wyo.-Mont.	May 26	Construction of the 47-mile Lovell-Yellowtail 115-kv transmission line.	Hall-Barovich Construction Co., Rapid City, S. Dak.	587,550
DC-6095	Missouri River Basin, Nebr.	June 11	Construction of 66 miles of Ainsworth laterals and wasteways, sections 3 and 4.	Bushman Construction Co., St. Joseph, Mo.	1,449,705
DS-6096	Central Valley, Calif	June 9	Four 17.5 foot by 22.89-foot roller mounted gates for outlet works trashrack structures at San Luis dam.	Mitsubishi International Corp., New York, N.Y.	300,000
DS-6097	Colorado River Storage, Colo.	June 25	Furnishing and installing two 33,333-kva generators for Blue Mesa powerplant.	Allis-Chalmers Mfg. Co., Denver, Colo.	968,787
DC-6099	Arbuckle, Okla	June 9	Construction of Arbuckle dam	Amis Construction Co., Oklahoma City, Okla.	2,956,822
DS-6104	Central Valley, Calif	June 2	Four frames for 17.5-foot by 22.89-foot roller mounted gates for outlet works trashrack structures at San Luis dam.	Star Iron and Steel Co., Tacoma, Wash.	141,220
DS-6105	Missouri River Basin, Mont.-Wyo.	June 9	One main control board, one relay board, and two graphic control boards for Yellowtail powerplant; and one lot of unmounted relaying equipment for Lovell substation.	Westinghouse Electric Corp., Denver, Colo.	193,068
DS-6108	Columbia Basin, Wash	June 3	Furnishing and installing one armature winding and furnishing only one armature winding for generators for Grand Coulee powerplant.	Westinghouse Electric Corp., Denver, Colo.	485,401
DC-6109	Parker-Davis, Ariz	June 15	Construction of stage 02 additions to ED-2 substation and construction of Signal substation, stage 01.	Homes and Son Construction Co., Inc., Pheonix, Ariz.	133,550
DC-6111	Colorado-Big Thompson, Colo.	June 16	Modification of Granby dam spillway	Gardner Construction Co., Grand Junction, Colo.	464,625
DC-6112	Eklutna, Alaska	May 5	Repair of earthquake damage to precast conduit of Eklutna tunnel intake. (Negotiated contract.)	Peter Kiewit Sons' Co., Omaha, Nebr.	133,859
100C-685	Spokane Valley, Wash	May 5	Drilling and casing thirty-one irrigation water-supply wells near Spokane, Wash.	Holman Drilling Corp., Spokane, Wash.	313,928
100C-694	Columbia Basin, Wash	June 19	Construction of 9.1 miles of buried pipe drains for drain systems, Blocks 75 and 76.	B & B Plumbing and Heating, Inc., Anacortes, Wash.	160,926
300C-212	Colorado River Front Work and Levee System, Ariz.	May 20	Construction of earthwork, precast-concrete pipe lines, and structures for pump outlet channel No. 3, South Gila Valley, Schedule 2.	Karl A. Dennis, dba Dennis Construction Co., Yuma, Ariz.	283,928
304C-156	do	Apr. 6	Construction of stage 02 additions to Gila substation and the 18-mile Gila-Senator Wash 69-kv transmission line.	Acme Power Line Construction, Inc., Salt Lake City, Utah.	215,603
400C-253	Colorado River Storage, Colo.	June 15	Relocation of 15.5 miles of Gunnison County Road No. 7	Vern W. Smith, Englewood, Colo.	229,893
500C-139	Rio Grande, N. Mex	Apr. 16	Construction of one 3-bedroom caretaker's residence, office and shop building, 3.5 miles of roads, boat launching ramps, parking areas, comfort stations, and water distribution systems for recreational facilities for Elephant Butte and Caballo reservoirs.	C & H Construction and Paving, Inc., Albuquerque, N. Mex.	311,659
500C-160	Wichita, Kans	May 20	Construction of 7.3 miles of roads, boat launching ramps, and parking areas for recreational facilities for Cheney reservoir.	Ritchie Brothers Construction Co., Wichita, Kans.	163,856
500C-161	San Juan-Chama, N. Mex.	May 12	Construction of ten 3-bedroom residences for Government camp at Chama, N. Mex.	The Banes Co., Inc., Albuquerque, N. Mex.	133,750
500C-167	Canadian River, Tex	May 15	Construction of roads, boat launching ramp, and parking area for recreation facilities for Sanford reservoir.	Kansas Earthmovers, Inc., Hugoton, Kans.	139,987
600C-205	Missouri River Basin, Mont.	Apr. 24	Relocation of 10.7 miles of Fort Peck-Great Falls 161-kv transmission line in vicinity of Glasgow, Mont.	Brink Construction Co., Rapid City, S. Dak.	118,778
700C-595	Fryingpan-Arkansas, Colo.	May 15	Furnishing and erecting prefabricated metal office building, laboratory building, drilling operations building, garage, and utilities for Western Slope features.	Ladwig Building and Manufacturing Co., Inc., Colorado Springs, Colo.	132,700

U. S. GOVERNMENT PRINTING OFFICE : 1964 O - 733-114

Major Construction and Materials for Which Bids Will Be Requested Through August 1964*

Project	Description of work material
Arbuckle, Okla	Four 3-ft by 6-ft 6-in. high-pressure gate valves; and two 2-ft 9-in. by 2-ft 9-in. high-pressure gate valves for Arbuckle Dam. Estimated weight: 180,000 lb.
Canadian River, Tex	Constructing about 140 miles of 8- to 72-in.-diameter pipeline of either noncylinder prestressed concrete pipe, steel cylinder pretensioned concrete pipe, steel pipe, concrete pressure pipe, or asbestos-cement pipe. Lubbock to Lamesa and Southwest Aqueduct, near Lubbock.
Central Valley, Calif	Constructing about 30 miles of 10- to 54-in.-diameter pipelines and two steel tanks. Pipelines are to be constructed of either noncylinder prestressed concrete pipe, pretensioned steel cylinder concrete pipe, steel pipe, asbestos-cement pipe, or concrete pressure pipe. Cow Creek Unit, near Redding.
Do	Constructing about 8 miles of 42- and 45-in.-diameter pipeline for hydrostatic heads of from 200 to 600 ft. Pipeline is to be constructed of either noncylinder prestressed concrete pipe, pretensioned steel cylinder concrete pipe, or steel pipe. Clear Creek South, near Redding.
Do	Constructing about 34 miles of 75-ft bottom width canal with 4.5-in. unreinforced-concrete lining, and appurtenant structures, including concrete bridges, pipe crossings, and checks. San Luis, Reach 3, near Los Banos.
Do	Constructing the Wintu Pumping Plant, an outdoor-type plant with a reinforced-concrete substructure; furnishing and installing four motor-driven pumping units of 100-cfs total capacity, mechanical and electrical auxiliary equipment, mechanical fishscreen and steel manifold. Constructing a 25- by 25-ft concrete masonry unit building and furnishing and installing chlorination equipment. Near Redding.
Do	Constructing the 12-ft 6-in.-diameter circular, concrete-lined Pacheco Tunnel inlet about 2 about 2 miles long to a bulkheaded heading (tunnel to be completed at a later date). Work will also include constructing a reinforced-concrete intake structure and gate shaft with a 7-ft by 12-ft 6-in. fixed-wheel gate, and constructing a 20-ft bottom width inlet channel about 1.7 miles long. Near Los Banos.
Do	Constructing about 8,000 lin ft of 80-ft bottom width San Luis Forebay Intake Channel, about 4,000 lin ft of which will be lined with 4-in.-thick unreinforced concrete; constructing about 2,200 lin ft of relocated Delta-Mendota Canal with bottom width of 48 ft, lined with 4-in.-thick unreinforced concrete; and constructing about 3,500 lin ft of Forebay Dam Wasteway Channel, with bottom width of 120 ft, including a reinforced-concrete baffled apron drop and a reinforced-concrete culvert drop under the Delta-Mendota Canal. Work will also include raising the concrete lining about 18 in. on about 65 miles of the Delta-Mendota Canal and modifying turnouts, drainage inlets, checks, siphon transitions, etc. Near Los Banos.
Do	Six 40,000-hp, 0.95-pf, 13,200-volt, vertical-shaft synchronous motors for mile 18 Pumping Plant.
Do	Seven 105,000-kva, 3-phase, 230- to 13.8-kv, triple-rated power transformers for San Luis and Mile 18 Switchyards.
Do	Four single-phase, 230 -to 4.16-kv, 10,000-kva power power transformers for Forebay Pumping Plant Switchyard.
Do	Eight 230-kv, 1,600-amp, 20,000-mva power circuit breakers for San Luis Switchyard.
Do	Main control board and unit control boards for San Luis Reservoir Pumping-Generating Plant.
Do	600-volt station-service switchgear for San Luis Reservoir Pumping-Generating Plant.
Do	Eight 14.4-kv station-type switchgear; 15-kv isolated-phase bus; two 2,000-kva, 13.8-kv to 480-volt station-service transformers; 600-volt nonsegregated-phase bus for San Luis Reservoir Pumping-Generating Plant.

Project	Description of work or material
CRSP, Colo	Clearing trees, brush, fences, and other structures from about 9,000 acres of the Blue Mesa Reservoir site, and furnishing and installing protective buoy system.
Do	Constructing a 100- by 178-ft machine shop and 48- by 112-ft service garage, steel framed with insulated metal wall panels and roof decking. Power Operations Center at Montrose.
MRBP, Kans	Constructing Glen Elder Dam, a 10,000,000-cu-yd earthfill structure, about 115 ft high and 15,000 ft long, and appurtenant features. The spillway will consist of a 644-ft wide, radial-gate-controlled, open-chute structure through the right abutment. The outlet works will consist of a cast-in-place, cut-and-cover conduit controlled at the downstream end by two 6-ft 6-in. by 8-ft high-pressure regulating gates. The upstream part of the outlet conduit will be 12-ft 6-in. in diameter and the downstream part will be 17-ft 6-in. in diameter. On the Solomon River, near Glen Elder.
Do	Constructing the first section of the Downs Protective Dike, Station 11+64 to 44+25, containing about 650,000 cu yd of earthfill embankment, about 20 ft high and 3,000 ft long, with a cutoff trench about 40 ft deep. Work will also include earthwork and structures for about 1 mile of county road relocation. Near Downs.
MRBP, Mont	Completing the Yellowtail Dam, Powerplant, and Switchyard will consist of installing four 87,500-hp, 225-rpm, vertical-shaft hydraulic turbines, the transformer bank, switchyard, and other electrical and mechanical equipment; placing concrete for turbine embedment and generator support; constructing a visitors reception unit and architectural features; and placing concrete floor surfacing and applying architectural finishes. On the Bighorn River, about 45 miles southwest of Hardin.
Do	Three 50,000-kva, 230-grd wye—13.2-delta-kv, single-phase, 60 cycle, FOW transformers; and three 50,000-kva, 115-grd wye—13.2-delta-kv, single-phase, 60-cycle, FOW transformers for Yellowtail Switchyard.
Do	Schedule No. 1—14.4-kv, isolated-phase, generator-voltage bus structures; 600-volt, low-voltage feeder busways; three 750-kva, 13.8-kv to 480-volt, station-service transformers.
Do	Schedule No. 2—14.4-kv, station-type, cubicle switchgear. All for Yellowtail Powerplant.
Do	Four 230-kv, 1,600-amp, 10,000-mva, oil power circuit breakers; four 115-kv, 1,200-amp, 5,000-mva, oil power circuit breakers; and one 14-4-kv, 1,200-amp, 1,000-mva, oil power circuit breaker for Yellowtail Switchyard.
MRBP, Nebr	Constructing the Dunlap Substation will consist of constructing a concrete masonry service building; constructing foundations; furnishing and erecting steel structures; transporting and installing one 3-phase, 6,000-kva, 115/69-kv transformer; furnishing and installing one 69-kv circuit breaker and associated electrical equipment; and grading and fencing the area.
MRBP, S. Dak	Furnishing and constructing about 20 miles of 115-kv, wood-pole transmission line; and furnishing and stringing three 556.5 MCM, 24/7, ACSR conductors, and two 3/8-in., high-strength, steel strand, overhead ground wires. New Underwood-Rapid City and Rapid City-Midland Ties to New Underwood Substation.
MRBP, Wyo	One single-phase, 230- to 115-kv, 33.3-mva, mobil autotransformer.
Parker-Davis, Ariz	Furnishing and constructing about 14 miles of 115-kv, wood-pole Coolidge-ED-2 Transmission Line; and furnishing and stringing three 795 MCM, 26/7, ACSR conductors, and two 3/8 in., high-strength, steel strand, overhead ground wires.

*Subject to change.

In its assigned function as the Nation's principal natural resource agency, the Department of the Interior bears a special obligation to assure that our expendable resources are conserved, that renewable resources are managed to produce optimum yields, and that all resources contribute their full measure to the progress, prosperity, and security of America, now and in the future.

Bureau of Reclamation
U.S. DEPARTMENT OF THE INTERIOR

Reclamation

ERA

November 1964

A First for the First Lady

Disaster Relief to Alaska and Montana

Nevada's Centennial—By Governor Sawyer

Reclamation ERA

NOVEMBER 1964

Volume 50, No. 4

OTTIS PETERSON, Assistant to the Commissioner—Information
GORDON J. FORSYTH, Editor

COVER PHOTOS—Utah Senator Frank E. Moss points to an interesting item for the attention of Lady Bird Johnson and Secretary Udall.

A damaged public building in downtown Anchorage.

Flood spills over Gibson Dam during Montana flood.

Nevada's 1964 Centennial seal

United States Department of the Interior
Stewart L. Udall, Secretary

Bureau of Reclamation, Floyd E. Dominy, Commissioner

Washington Office: United States Department of the Interior, Bureau of Reclamation, Washington, D.C., 20240.

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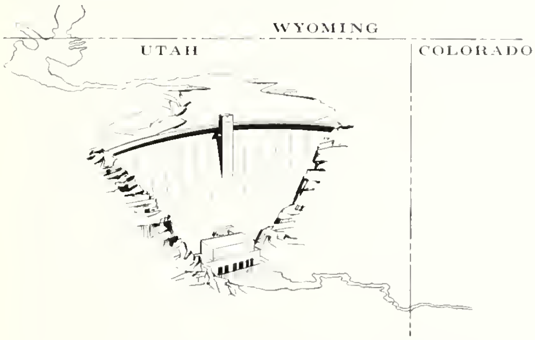
Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C., 20240. Use of funds for printing this publication has been approved by the Director of the Bureau of the Budget, January 31, 1961.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Price 15 cents (single copy). Subscription price: Eight issues (2 years) for $1.00 ($1.50 for foreign mailing).

President Johnson's Wife Dedicates Flaming Gorge Dam—



A FIRST FOR THE FIRST LADY

The First Lady of the United States, Mrs. Lyndon B. Johnson, on August 17, became the first lady in history to dedicate one of the West's huge Reclamation dams—Flaming Gorge Dam.

Standing on a specially constructed platform overlooking the 502-foot structure located in spectacular wilderness country, the President's wife told a receptive crowd of about 1,500 people that "this dam proved that big dreams can come true." She was greeted and escorted to the speaker's platform by Reclamation Commissioner Floyd E. Dominy.

Commissioner Dominy opened the dedicatory ceremony with an introduction of Secretary of the Interior Stewart L. Udall, the master of ceremonies. Secretary Udall accompanied Mrs. Johnson on her entire 4-day tour of Montana, Wyoming, Utah, and Idaho.

Mrs. Johnson unveiled a plaque bearing her name which will be installed permanently at the dam to commemorate the occasion.

After the dedication, Mrs. Johnson led a bus caravan to the Antelope Flats landing on the east shore of Flaming Gorge Lake. Here she boarded a boat for a brief lake cruise, docking on the east shore at Lucerne Valley landing about a half hour later and headed for Green River, Wyo., and a western-style buffalo barbecue. At this stop, the First Lady dedicated Flaming Gorge Recreation Area.

Also on the 4,200-mile trip, Mrs. Johnson was adopted into the Crow Indian tribe in Montana; made her headquarters at Jackson Lake Lodge, Wyo., overlooking Reclamation's Jackson Lake; took a 30-mile float trip down the Snake River; visited Vernal, Utah, and gave speeches at both Salt Lake City, and Park City, Utah. She also made other brief appearances including airport stops at Idaho Falls, Idaho, and Denver, Colo.

The text of the First Lady's remarks at Flaming Gorge Dam follows.

"No one can follow the trail I have followed the last 4 days without catching the spirit of the West. It has been the spirit of adventure which made bold pioneers and brave frontiersmen—the spirit of optimism which caused men and women to dream big and build big.

"John Wesley Powell, the geologist-explorer who named Flaming Gorge, showed such a spirit. About a hundred years ago, he made his daring journey down these rapids while studying the water system of the mountain region. And he dreamed dreams about a network of huge dams which could cause this arid land to flower.

"I feel a kinship to Powell, for my husband and I have also dreamed of dam building—though much further to the south where the Green River becomes one with the Colorado. During Lyndon's first years in Congress back in 1937, he devoted his prime energies to the program for harnessing water for man's use. Today, we get a special pleasure when we drive through central Texas past the lakes and reservoirs and watch the fishermen and water skiers. Wise use of water has enriched the quality of our lives as much as it has increased the quantity of our resources.

"How many people have dreamed and planned and built to bring this great reservoir into being! I wish John Wesley Powell could again board his boat at Green River City and float through Flam-

Seated behind Mrs. Johnson as she speaks at the dedication are: Arthur V. Watkins, former U.S. Senator from Utah; Gov. George D. Clyde of Utah; U.S. Senator Frank E. Moss of Utah; Secretary of the Interior Stewart L. Udall, and U.S. Senator Gale W. McGee of Wyoming. Partially hidden at right is Reclamation Commissioner Floyd E. Dominy.

ing Gorge to see how much greater today's reality than yesterday's dream. I also wish my husband could be here because he believes strongly that the age of adventure is not over.

"The battle of the future, as my husband defined it at the University of Michigan, will be waged in both the countrysides and the cities. In this spectacular wilderness you have already done a great deal to win the battle for the countrysides. Both your natural beauty and your wildlife will be safer, now that the wilderness bill has passed both Houses of Congress.

"But what of your cities and towns? Here, too, your dream is a great one. Brigham Young once voiced it, 'Let the people . . . make beautiful cities, in which may be found magnificent edifices, for the convenience of the public, handsome streets, skirted with shade trees, fountains of water, crystal streams; and every tree, shrub, and flower that will flourish in this climate, to make our mountain home a paradise.'

"I urge you not to forget these dreams. Let us remember these pioneers. Americans have always felt that the tomorrow of our children should be better than the yesterday of our parents. We share a faith in life that the best is yet to come; that we must build our future, not belittle it.

"In this spirit and with this wish, I dedicate your Flaming Gorge Dam."

On September 27, 1963, the late President John F. Kennedy gave the signal from the Salt Lake City Airport to start test runs on the first generator at Flaming Gorge Dam and powerplant. Commercial generation of power was initiated on November 11 of that year. The 108,000-kilowatt powerplant at the toe of the dam houses three generating units which are sending hydroelectric power over transmission lines to users in Utah, Wyoming, and Colorado. # # #

(Flaming Gorge Dam photo on next page is by Stan Rasmussen)

By Stout Hearts and Teamwork . . .

Wracked Alaska Had Power

The vast landmass called Alaska encompasses nearly 600,000 square miles, yet by virtue of a small population it is as intimate as a small town. South-central and southeast Alaska, however, are separated by sea, mountains, and icefields, and they are two time zones apart.

Thus, at 5:35 p.m. on March 27, while the south-central part of the State (Anchorage, Seward, Kodiak, and Valdez) was returning home from the day's business or preparing the evening meal, the southeast (Juneau, Ketchikan, and Sitka) was leaving for Good Friday night services or settling down for the evening's fare of 2-week-old programs on TV.

As communications from the quake-shattered south-central were wiped out, it was late in the evening before the southeast knew what had happened. First reports were garbled and exaggerated. Familiar names of people and locations of damage came crackling over the airwaves, catching people of the southeast in a horrible web of helpless anxiety. There were rumors of a great tidal wave heading for the Juneau area, which fortunately did not materialize. All of Alaska that night and for days to come was linked by one great heartline—the radio.

In Anchorage, when the earthquake started, most people were unconcerned—for the first few seconds, that is—because, as in California, minor tremors are not uncommon. This first reaction changed quickly to alarm, to fear, and then to terror as the ground heaved, buildings swayed wildly, and the world seemed to be tearing itself apart. Great cracks appeared in the earth, and whole areas dropped as much as 20 feet, carrying homes and commercial buildings to destruction. An entire section of Anchorage's most exclusive residential subdivision, on a bluff overlooking Cook Inlet, literally fell into the sea.

In the Bureau of Reclamation's District Office in Juneau, the first concern was for the personnel and the families of the Eklutna hydroelectric project just outside of Anchorage. Eventually, a roundabout telephone contact was made. All of our people were safe, but the project had suffered severe damage. Typical of early accounts was that of Powerplant Operator David Draze, who was on duty at the time:

> During the first 10 or 15 seconds I thought we were experiencing a very severe quake. As it became more violent the plant relayed off and we were in darkness. The plant began to heave and sway in a violent manner, so that it was hard to keep on our feet or move around. There was a very loud booming noise and I thought that an atom bomb had been dropped and triggered off a landslide which was covering the plant.

The report goes on to tell about the overhead crane that was crazily moving about on its track in the generator room and the large transformer doors that were straining at their hinges.

Items Flung About

Simultaneously, the project office was getting some shuffling about—filing cabinets toppled over, bookcases spewed their contents, light fixtures flung about, and the water pump raised 6 inches off the floor as the whole building settled.

At the camp, the houses were swaying and sailing pictures and bric-a-brac in wild confusion about the interiors. Many stories tell of strange culinary concoctions on kitchen floors as cupboards and refrigerators disgorged molasses, catsup, honey, salad oil, detergents, and other assorted ingredients. Cleanup in some areas was made more challenging by lack of water due to broken water pipes. For Mrs. Williams, the wife of the project superintendent, cleanup would have to wait, for she was busy at the office handling traffic on the project radio system.

Gratefully, there were no injuries to Bureau personnel. The office and homes sustained damage to chimneys, fuel lines, wiring, and personal items, but all were habitable (after shoveling out the unpalatable debris).

Walter Williams reported that all employees arrived as quickly as possible for work and continued on the job for as many as 27 hours without a break. They drove over roads that were heaved

Army helicopter assisting in setting poles on Eklutna-Palmer 115,000-volt line.

Divers preparing to do repair work in a chilly 50 feet of water in Eklutna Lake.

A special power scraper (at top of photo) was devised to go in Eklutna Tunnel and clean out the sandy muck.

and cracked, and those living on the other side of the Knik River had to walk across the damaged bridge and then climb over two huge snowslides.

Amazingly enough, the powerplant was placed back in service in 20 minutes, furnishing electricity to the plant, office, and camp, but system damage, as yet unknown, precluded the immediate delivery of power to customers. The first look at outside facilities disclosed severe damage to the high-voltage circuit breakers that connect the plant to the transmission lines serving Anchorage and Palmer, making them unusable. These were quickly bypassed by temporary jumpers, and the line to Anchorage was energized. At the Bureau's Anchorage substation, emergency measures had already been accomplished to permit restoration of service to the city's system and to that of the Chugach Electric Association. A CEA linecrew was rushed to the substation to help out on this work.

The Palmer line was unusable because of a snow and rock slide that had swept away a structure and two spans near the Knik River bridge and then roared on down the mountain to block the highway and come to rest halfway across the Knik River. Service to Palmer and the Matanuska Valley was restored over a 34,500-volt standby line owned by the Matanuska Electric Association, whose crews had it repaired and ready for use within a few hours after the quake.

The next crisis came at midnight when the water supply to the plant ceased. . . . Could it be a collapsed tunnel; had Eklutna Lake gone

dry, or was the power intake at the lake in trouble? Mr. Williams made a hurried 20-mile trip to Eklutna Lake to find the dam intact and no apparent damage, except some obvious land movement around the lakeshore. He returned to the powerhouse and proceeded to nurse water through the plant until a huge earth plug in the waterway was dissipated. He wondered at the time if he should report the power production in terms of kilowatt-hours per acre-foot of sand!

For the next 6 weeks the plant was to operate on an emergency basis with periodic alternate shutdown of units to remove sand and rocks and to clean out the cooling water system. There was, for all plant personnel, the 24-hour anxiety that the next rock (some were as large as footballs) would completely immobilize the plant.

Intake Pipe Separates

In the meantime, diver inspection on April 12 disclosed a separation in the 9-foot-diameter intake pipe which connects the 4½-mile-long pressure tunnel to the intake structure in the lake. The overburden over this separation contributed an estimated 2,000 cubic yards of dirt, sand, rock, sticks, and similar debris during the next several weeks until the plant could be shut down on May 9 for repairs to the intake and a complete inspection of the waterway.

The cooperation of Matanuska Electric Association was invaluable after the quake. Since the Knik River slide had cut the Eklutna-Palmer 115,000-volt line, the main power source for the Matanuska Valley, all power had to flow through the Reed substation where only limited capacity was available. MEA furnished truck-mounted electric fans to keep cold air blowing on the overloaded transformer. The transformer held while project line maintenance personnel, with help of an Army helicopter and supported heavily by linemen and materials furnished by MEA, completed repairs high up on the mountainside.

Excellent cooperation was exhibited throughout the Bureau "family." Region 7 personnel quickly dismantled a 115,000-volt switch from the Gering, Nebr., substation and hauled it through a snowstorm to Lowry Field in Denver for transport to Alaska by the New Mexico Air National Guard. An electrician, skilled in the asembly of this type of equipment, was dispatched from the Watertown, S. Dak., office in Region 6 to handle the installation.

The chief engineer's office in Denver dispatched several teams of technical experts to assess damage and to develop repair plans. That office also ordered emergency parts from manufacturers and furnished emergency operating procedures. Region 7 sent an experienced technician to make a complete mechanical check of the turbines, and Region 1 was called upon to furnish personnel to make a thorough Doble test of all electrical equipment.

During this period, power agencies in the area were doing a herculean job of coordinating operation of their respective generation facilities to provide an adequate supply of power. The city of Anchorage overcame the problems of a ruptured oil storage tank and severed gasoline to get its gas turbines and diesel-driven generators in operation. Chugach Electric Association returned its Knik Arm steamplant to full operation a little at a time as boiler and other structural damage was repaired. The military systems suffered loss of cooling water facilities, which reduced plant capability to the point where only the essential needs of the military bases could be supplied. Chugach, in addition, was fighting the battle of high tides and floating ice in Turnagain Arm where loss of its 115-kilovolt line on several occasions denied the Anchorage area the output of the Cooper Lake hydroplant.

Underwater Repair Work

As soon as there was reasonable assurance that power suppliers other than the Bureau could handle the Anchorage-Palmer area loads, the Peter-Kiewit Co. under a negotiated contract began underwater repair work and mucking in the upper reaches of the tunnel and intake. At the same time Government forces, which were increased fourfold, began the job of cleaning out the remainder of the tunnel and the tailrace and inspecting and correcting many other items. On July 2, the plant was returned to full operation, permitting the other agencies to remove units from service and perform needed maintenance and permanent repairs.

Since the repairs to the intake are considered only temporary, three half screens have been installed in the tunnel to catch any vagabond rocks and thus protect the turbines from further battering. Plans are now being drawn up that will call for a new intake structure, repair of the

(*Continued on page 107*)

From Nevada's Capitol at Carson City, Governor Sawyer tells about vital water developments and the variety of other bonuses which make his the fastest growing U.S. State.

ATTLE BORN" STATE IS 100 YEARS OLD

by GOVERNOR GRANT SAWYER

The Silver State of Nevada, which is celebrating its 100th birthday this year, is proving to the rest of the Nation how a State can progress and prosper with enlightened resource management programs.

Nevada is proudly sharing its colorful past and exciting future with residents and visitors alike during this centennial year. Within its 110,000 square miles of picturesque mountains, peaceful desert valleys, and rural life on fertile farmlands, Nevada's attractions range from the world's most spectacular stage shows and the lure of legal gambling to unlimited outdoor recreation in natural scenic wonders.

Short drives take the visitor from the Reno-Sparks area into the lush pine forests of the Sierra Nevada Mountains or into the Lahontan Desert to search for Indian artifacts. Tourists who visit fabulous Las Vegas are surprised to learn that they can drive to the ski areas of Mount Charleston in less than 1 hour. The possibilities for recreation and entertainment in this land of contrasts are endless.

Modern Nevada history had its beginnings around 1775, when Father Escalante, a Spanish priest, was believed to have led an expedition into southern Nevada. He was followed by other explorers of the West in the early 1800's—fur traders Jedediah Smith and Peter Ogden; John C. Fremont, whose expedition was guided by the famed scout Kit Carson, and Joseph Walker, who gave his name to a river and lake in Nevada.

California began attracting waves of immigrants in the early 1840's. Weary pioneers traveling the Old Spanish Trail rested in the lush meadows near Las Vegas before starting the rugged journey across the desert to California. At Nevada's first permanent settlement, Mormon Station (later called Genoa), wagon trains stopped for supplies before embarking on the dangerous trip across the Sierra Nevada.

To these early travelers, the Nevada Territory itself held little interest. It was merely regarded as the final obstacle to be crossed in the trek to California.

A flood of settlers poured into Nevada, however, with the discovery of the Comstock silver lode in 1859. This rich mineral find changed the face of the territory and even influenced a Nation moving rapidly toward civil war.

Virginia City miners were transformed into millionaires overnight and they invested their Nevada

wealth in San Francisco to make it the financial center of the West. This vast virgin land, which only a few years earlier was charted as "unknown" on maps, became the most-talked-about area in the world.

In 1861, the Territory of Nevada was created by Congress. Then, at the height of the Civil War in 1864, President Abraham Lincoln discovered he needed one more vote to ratify the antislavery amendment to the U.S. Constitution and Nevada, the "battle born" State, was admitted to the Union.

For a time, Nevada silver became a potent international, financial, and political force. Bankers from London to Berlin were convinced that Nevada's seemingly inexhaustible supply of silver would reduce the value of that metal below that of iron.

Thus, in 1864, Nevada was little more than a collection of mining camps. Most of them, such as Virginia City, Silver City, and Gold Hill, were located on the Comstock, but others sprung up in the central and eastern part of the new State.

Life in the early mining "boomtowns" was often sumptuous and elegant and rivaled anything found in San Francisco or New York. Virginia City had its own opera house, which booked the top names of the entertainment world in that bygone era.

The price of silver, however, was driven lower and lower. At the same time, operating costs skyrocketed and several of the richest strikes were worked to exhaustion. Eventually, the price of silver dropped to as low as 28 cents an ounce and the mining business became generally unprofitable.

Other Metals Mined

Mining has experienced a rebirth of sorts in recent years. Other metals have been discovered in Nevada and they are in demand in space age industries. Today, Nevada is the fourth largest exporter of iron ore in the Nation. There are two huge open-pit copper mines in the State and some gold and silver is still being mined.

Even before its big silver mining industry went into the doldrums, Nevada was developing other

The Truckee River flows through the heart of busy Reno.

industries. Livestock—especially cattle—was fluorishing on ranches and open ranges with many large spreads located in the Elko and Winnemucca areas.

By the 1880's, when even the best silver strikes were nearly exhausted, Nevada was in a full-scale economic transformation. Its lumbering industry, which was centered around Lake Tahoe during the Comstock's wildest days, was still active with steamships plying the lake and railroads transporting lumber to markets on the coast. Farms sprung up in fertile areas such as the Washoe, Carson, and Mason Valleys of western Nevada.

Gambling, which was destined to become Nevada's major industry, was common in early-day mining camps. It was technically illegal when the Nevada Territory was created in 1861 and the situation remained the same after Nevada became a State in 1864. In 1869, however, the State legislature legalized gambling despite bitter opposition from Gov. Henry G. Blasdel, the State's first chief executive.

After being outlawed again in 1910, most of the present-day forms of gambling were legalized for the final time in 1931 to provide additional revenue during the depression.

The State began to tax and control the gambling industry in 1945 and, during the intervening years, a widely respected system of control has been developed with the primary goals of insuring the honesty of casinos and guarding against hoodlum infiltration of the sensitive industry. Sharing responsibility in these vital tasks are the investigative State Gaming Control Board and the parent Nevada Gaming Commission.

Nevada gamblers paid $13.5 million in taxes and fees to the State last year based on gross winnings of approximately $261 million. The tax and fee figure placed Nevada seventh among more than 30 States that collect revenue from legal gambling. States leading Nevada in such collections are New York, California, Florida, New Jersey, Illinois, and Massachusetts.

Munitions Factories

Another important industry to Nevada got its start during the World War II years. It was discovered that, because of surrounding mountains, Nevada offered natural protection against possible enemy attack. As a result, munitions factories were built in Henderson near Las Vegas and in other communities.

These new factories, in turn, attracted thousands of new residents to Nevada. Within less than 20 years, the State's population quadrupled and the end to this fantastic growth is nowhere in sight. Percentagewise, Nevada is by far the fastest growing State in the Nation.

Following World War II, transportation facilities were improved and millions of tourists began to discover Nevada as a vacation paradise. Twenty million tourists visited Nevada last year to place the State far ahead of such well-known attractions as Florida and Washington, D.C.

Las Vegas, which was little more than a southern Nevada desert stage stop for many years, suddenly blossomed forth with multimillion-dollar resort hotels. Reno and Lake Tahoe also attracted a considerable number of visitors to northern Nevada.

In the relatively short span of 100 years, Nevada changed from a rugged frontier State into a modern, dynamic part of the New West.

Proper management of natural resources has assumed increasing importance during Nevada's period of rapid expansion. Lakes, rivers, mountains, and forests lure hunters, fishermen, and hikers and tourists interested in water and snow sports. At the same time, the State's burgeoning population has placed severe demands on the limited water supply.

Water has been described as the key to Nevada's future. Agencies of the Federal and State governments have cooperated through the years to manage Nevada's water resources in the best interests of the public.

Although Nevada is rich both historically and literally in water resource development, it is a land of perpetual drought. The Newlands project near Reno was authorized in 1903 as one of the original projects under the Reclamation Act of 1902. It is celebrating its 61st anniversary this year.

Some 25 years later, Hoover Dam, located on the Colorado River on the Nevada-Arizona border, was authorized for construction by the Bureau of Reclamation as the first of the great multipurpose projects.

Hoover Dam is the pioneer of the Nation's mammoth reclamation developments. The dam, which was authorized in 1928 and built during the 1931–35 period, was selected by the American Society of Civil Engineers as one of the Nation's seven modern civil engineering wonders.

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What better place for a young painter to paint than at Hoover Dam.

Built in a desert region declared worthless by the War Department in 1857, Hoover Dam is today an established symbol of the many benefits of multipurpose water resource planning. Benefits accruing to the Southwest from the project include flood protection, river control, water storage, and conservation for irrigation, municipal, and industrial uses, generation of low cost hydroelectric energy, improvement of navigation, recreation and preservation of fish and wildlife.

Hemisphere's Highest

Hoover Dam, which rises more than 700 feet above bedrock, is still the Western Hemisphere's highest dam. Its construction backed up water for 115 miles to form Lake Mead with some 550 miles of shoreline. This is one of America's most popular recreation areas.

A second reservoir, Lake Mohave behind Davis Dam, is also part of the Lake Mead National Recreation Area. The National Park Service reported that more than three million persons visited the area last year to fish, hunt, picnic, camp, swim, water ski, or to relax in quiet natural surroundings.

The previously mentioned Newlands project is located on a level, gently rolling, 87,000-acre section at about 4,000 feet above sea level in western Nevada. The principal crop of the area is alfalfa, which provides feed for cattle, sheep, and hogs. The alfalfa crop was valued at nearly $2.3 million in 1962.

Lake Tahoe Dam creates a reservoir of 732,000 acre-feet of water and is especially important to the Newlands project. Also included is Lahontan Dam and Reservoir on the Carson River.

Lake Lahontan, created in 1915, is rapidly becoming an outstanding recreational facility for boating, swimming, picnicking, and camping.

The lake's fresh water is constantly being replenished with melting snows from the surrounding mountains and is fast becoming a popular spot for campers, boaters, water skiers, picnickers, and swimmers.

The nearby city of Fallon is symbolic of the benefits derived from irrigation. It has a modern high school, locally owned utility systems, a swimming pool, modern hospital, municipal airport, and golf course, several small industries, and a large naval air station.

Other Federal Reclamation projects in Nevada include the Truckee Storage project on the Little Truckee River near Reno, and the Humboldt project on the Humboldt River system near Lovelock. These projects, completed in 1939 and 1936 respectively, have reservoir storage development totaling more than 200,000 acre-feet. They provide many water resource development benefits to the important areas they serve—Truckee Meadows near Reno and Lovelock Valley some 100 miles to the northeast.

A newly authorized development is the Washoe project on the Carson and Truckee river systems. Reservoir construction is proposed at three major development sites with an aggregate storage capacity of more than 400,000 acre-feet. This vital project will provide supplemental irrigation and drainage service to agricultural lands. It will develop municipal and industrial water, thus assuring continual growth to Reno, Sparks, Carson City, and other cities in western Nevada and eastern California. The project will greatly reduce devastating floods which the area frequently experiences. It will provide hydroelectric power, enhance fish and wildlife, and establish outstanding recreational facilities for the growing population. Prosser Creek Dam, completed in late 1962, was the first completed major facility of the Washoe project and has served well its intended purposes of flood protection and fishing enhancement.

Two Other Projects

Meanwhile, two major projects will assist southern Nevada farms and cities in utilizing the Colorado River and other water resources to avert a future water shortage.

These are the southern Nevada water supply project and the Moapa Valley pumping project.

The U.S. Bureau of Reclamation is currently attempting to determine the most economical and feasible means to provide an adequate water supply to meet present and future requirements of the Las Vegas Valley area. The necessary water would be pumped from Lake Mead and would be part of Nevada's allocated share of Colorado River water.

The total project plan would include a pumping plant on Lake Mead, a main aqueduct, five smaller pumping plants, a dam, reservoirs, and several miles of laterals.

Among the principal features of the proposed Moapa Valley pumping project would be a pumping plant on Lake Mead and an aqueduct to pro-

vide Colorado River water to the Lower Moapa Valley in exchange for part of the present supply obtained from the Muddy River.

Water resources of Nevada encompass both surface and underground supplies. Surface water supplies are only nominally developed but the development of ground water resources has been extensive.

Major ground water sources exist in the Las Vegas and Pahrump valleys of Southern Nevada as well as many other valleys in central and northern Nevada. In a few valleys ground-water extraction presently exceeds the annual recharge.

Continued growth of the industrial complex in Las Vegas and nearby Henderson depends to a large extent on water and power benefits from Hoover and Davis dams and powerplants. The U.S. Bureau of Reclamation, which operates these facilities, estimates that more than 95 percent of Nevada's hydropower resources have been developed.

Lake Tahoe, rimmed by the snow-clad Sierra Nevada Mountains, is certainly one of the most beautiful natural attractions in the entire United States.

The Nevada Legislature acted wisely earlier this year to preserve a sizable portion of the remaining undeveloped shoreline at Lake Tahoe for public usage.

The State conservation department has had potential Lake Tahoe parklands appraised and negotiations are underway with private foundations for land acquisition funds. If these funds are secured, the Federal Government will pay part of the cost.

The Lake Tahoe park project has the backing of most Nevadans, the U.S. Interior Department, and numerous private conservation groups.

One problem Nevada has faced is that some 87 percent of the State's land area is federally owned. There have been several proposals to make low cost Federal land available to private citizens and the Nevada congressional delegation has worked to modernize outdated Federal land laws.

The Federal Government, of course, has put some of its Nevada desert land to good use. The Nevada Test Site north of Las Vegas is a vital link in America's nuclear research programs.

The Nevada landscape in 1964—dotted by modern schools, housing developments, business complexes, and recreational facilities—bears little resemblance to the harsh desolation faced by early pioneers in the area.

Nevada ranchers on horseback.

This State has undergone a dramatic change from its original economic base built on the strength of its mineral wealth. The exciting Comstock Lode of 100 years ago, which yielded nearly a billion dollars in silver and gold and dominated the economic and political structure of a fledgling State, now is but a memory.

No longer dependent on the ore from its mines, Nevada is today a vacation mecca for millions of tourists, a new center for light industry and the national leader in per capita growth and prosperity.

One writer described Nevadans this way: "*They are likely to try anything, because this land has little history of failure and less of restriction.*"

Nevada and the New West are playing progressively more significant roles in the current migration of population, industry, and political power that is already changing the historic structures of American life. # # #

Montana's 100th Territorial Anniversary . . .

FROM GOLD TO PRECIOUS WATER

In 1864—a year of colorful pioneering events in the northwest—Montana became a territory. Montanans are celebrating not only the territorial centennial, but also the 75th year of statehood.

In saluting the State, the Bureau recalls some episodes of history which took place at or adjoining the Bureau-built water control structures. The rugged and profitable mining work of the prolific early gold resources brings to mind many of the almost legendary events and caused the establishment of the first government.

The first important gold mining operations at Bannock on Grasshopper Creek and at Virginia City in Alder Gulch were also the first capitals for the new territory's legislative assemblies. In 1875 the capital was moved to Helena where it has remained.

Starting at Three Forks, Mont., the Missouri River, the Nation's longest, begins 2,465 twisting miles to its mouth several States away. Although it has been said by residents living along the "Muddy Missouri" that its water is "too thick to drink and too thin to plow," clear water does come from the Gallatin, the Madison, and the Jefferson tributaries that form the great river's headwaters.

The record of the Lewis and Clark expedition through the State contains intriguing history. The expedition left camp identification and maps of its trail. Montana has established a State park at the Three Forks point. A number of other known Lewis and Clark sites, such as Fortunate Camp Monument, have been marked by signs.

Preserving the route as a memorial was first suggested by the late J. N. (Ding) Darling. In followup, the Bureau of Outdoor Recreation is seeking the cooperation of other Federal agencies and the States involved to mark and preserve the famous trail.

It is found that nearly half of the 846 days of the expedition from St. Louis to Fort Clatsop and return were spent in Montana.

On Sunday, July 21, 1805, Captain Lewis camped just beyond a narrow of the Missouri River Valley, a point that a century and a half later became the site of the Bureau of Reclamation's Canyon Ferry Dam. His description of the area has been preserved as he wrote it: "The country was rough mountainous & much as that yesterday untill towards evening when the river entered a beautifull and extensive plain country of about 10 or 12 miles wide which extended upwards further than could reach," Captain Lewis noted.

The multiple-purpose Canyon Ferry Dam, completed in 1954, creates a reservoir of striking blue water in the mountainous country located 17 miles from Helena and 58 miles from Three Forks.

The Sunday camp and two subsequent camps are now covered by the waters of Canyon Ferry Lake. Two days before the Sunday camp, Captain Lewis had observed, ". . . the most remarkable clifts that we have yet seen . . . from the singular appearance of this place I called it the gates of the rocky mounatains."

In the late evening of July 19, Lewis entered the gates of the Rocky Mountains. The next evening, he noted in his Journal, "I was obliged to continue my rout untill sometime after dark before I found a place sufficiently large to encamp my small party. The prickly pears are so abundant that we could scarely find room to lye."

Sgt. John Ordway, who had served as one of the 43-man Lewis and Clark corps of discovery, descended the Missouri River on a voyage of his own in 1807, then for almost half a century only a few white men traversed the winding river with its "crouded" islands. After the fur trapper seek-

Mementos such as this one honoring Sacajawea, the Indian girl guide, are taken from reservoir sites and preserved.

ing beaver and otter, prospectors came looking for gold.

Gold was discovered in Last Chance Gulch, the site that later became Helena (on July 14, 1864), and during the following months, hundreds of gold seekers staked claims on many creeks and gulches.

A river ferry first placed in service by John Oakes in 1865 enabling a crossing from Last Chance to the mining operations on the east side of the Missouri River was the origin of the name Canyon Ferry.

Today, a county road on the crest of Canyon Ferry Dam is the method used to cross the river.

The western slopes of the Big Belt Mountains near Canyon Ferry Dam are furrowed by creeks, large and small, a number of which carried gold in their beds or deposited gold on terraces on their way to the Missouri. For several fabulous decades, the gold camps made this area famous.

Near the Canyon Ferry community serving the dam and powerplant, today's motorist can turn on a south road which parallels Canyon Ferry Lake. He will drive by the famous gold-camp gulches—Cave, Magpie, Avalanche, Hellgate, White, and Confederate.

Cave Gulch Scene

Muriel Sebell Wolle's "Montana Pay Dirt" relates a story like a modern movie drama:

Cave Gulch was the scene of a fight between organized claim jumpers and mine owners in 1865, before official United States laws protected Montana territory. This party of men came from Idaho and Nevada, attracted by the wealth of Confederate Gulch well aware that as yet no laws existed which could touch them. Their headquarters was Cave Gulch, satisfactorily inaccessible yet close to good prospects. After they ordered two miners to leave their diggings by the following day, the lawful owners enlisted the aid of twenty prospectors from five nearby camps. These men, well supplied with provisions and ammunition holed up in a cabin near the disputed claim and waited for the jumpers to reappear. At dusk a dozen of the thieves showed up, ready to take possession of the seemingly abandoned property. As soon as their leader stepped up to the flume, a shot from the cabin killed him. His henchmen opened fire and for a few minutes the sniping continued from both sides. Finally the miners burst from the cabin and fought in the open, killing three of the jumpers. The rest hit for the timber and got away.

Stanley Vestal wrote in his "The Missouri" that "Confederate Gulch outdid all the rest."

It was named for some Confederate soldiers taken prisoner in Missouri by the Union forces and sent upriver. As the Civil War drew to a close, two of these fell to prospecting, operating in the Big Belt Mountains east of the river. There they soon found gold enough. Prospectors swarmed in—some of them experienced miners; others utter greenhorns.

One of these latter, they say, was so green that he went up to an old-timer busy with his pan and asked him to point out a better place to dig.

The shaggy miner straightened up and stared for a moment at his naive questioner. Then he looked around—to pick out the least likely spot in sight. He spat and pointed up the creek. "Try that bar yonder. Who knows? Maybe you will find something."

Taking the advice in good faith, the greenhorn followed the miner's directions, staked his claim, Montana Bar, and went to work. The bar covered about two acres. It has been called "the richest acre of gold-bearing ground ever discovered in the world." Up to that time, yields thereabouts had never gone above $180 to the pan, but that greenhorn found gravel yielding over a thousand dollars to the pan! Panfuls of clean gold were taken out of Montana Bar at a single cleanup, weighing some seven hundred pounds and worth $114,800. A single shipment by wagon to Fort Benton—over two tons of gold—was valued at more than a million dollars. Within four years the gulch produced ten million dollars in dust and nuggets.

Numbers of nuggets were found in the region worth from $100 to $1,800 each; several were valued at more than

$3,000 each. Some of the ore was so rich that it was shipped by wagon to Fort Benton, by boat to sea, and by ship to the British Isles—and still made a handsome profit.

The tales told about Confederate Gulch and Diamond City are legend. As recalled in "Montana Pay Dirt":

> The years 1865–1868 covered Diamond City's boom. During this period, roads were built to the camp from all directions, and daily stage service was established with Last Chance by way of Canyon Ferry. By 1880, however, the population had dropped to sixty, and when Judge Cornelius Hedges visited the camp in 1883 he wrote: "Diamond City is desolate, deserted and dreary."

Old Villages

The waters of Canyon Ferry Lake now cover the site of another pioneer village, Canton, formerly a supply center for prospectors and miners which later became known as the Gaab Ranch. Among the structures used as ranch buildings were an old hotel, a dance hall, a dry goods store, a saloon, and a bunkhouse. St. Joseph's Church, located one-fourth of a mile south of Canton, was erected in 1876. In 1952, under a relocation agreement with the bishop of the Helena Diocese, the Bureau of Reclamation moved the Canton Valley Catholic Church about 2½ miles to a new site.

The frontier settlement, Canyon Ferry, on the east bank of the river, was started in 1865. As late as 1948, there was a frame store, a row of abandoned log cabins, and a combination post office, stage office, stage barn, and a saloon. The original hotel burned in the early 1920's.

Canyon Ferry Cemetery, now a tiny island in Canyon Ferry Lake about a mile from the new dam, was established on the crest of a hill overlooking the valley and the village of Canyon Ferry. About 30 pioneers were buried there.

The late court sheriff, whose father started in business at Canyon Ferry in 1865, said, in an interview with The Independent Record (Helena) on July 29, 1956, that he remembered many burials at the cemetery, adding that none of the graves had been removed even though the only accessible way to visit them is by boat.

The old Canyon Ferry Dam and hydroelectric plant, adjacent to the village, was itself an historical feature, being the first structure to span the Missouri River. The dam was built in 1898 by the Helena Water & Electric Power Co.

Groundbreaking ceremonies for construction of the new Canyon Ferry Dam and powerplant were observed on July 21, 1949, 144 years from the date when Captain Lewis camped near the site.

The 19,800-acre East Bench Unit now reaching completion, and all other potential irrigation units in the Three Forks Basin, would not be possible without Canyon Ferry Dam.

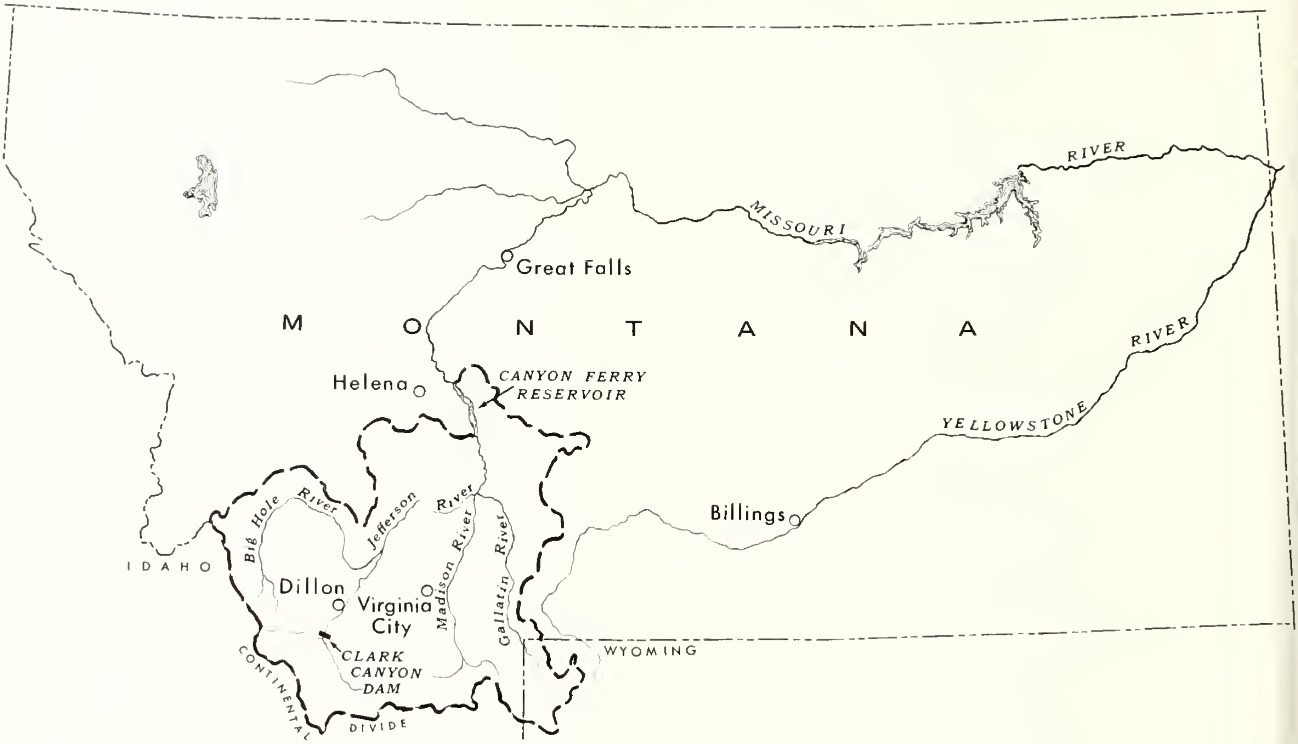
It was at the forks of Red Rock River and Horse Prairie Creek that Lewis and Clark met Cameahwait, a Chief of the Shoshones, and obtained the horses needed in their western journey to the Pacific. Just below the forks, where the Beaverhead River begins, the Bureau of Reclamation has constructed Clark Canyon Dam, the storage feature of East Bench Unit.

Fortunate Camp Monument, located within the Clark Canyon Reservoir area, describes in bronze the expedition and the assistance given to the explorers by the Indians. Constructed by the State Highway Commission of Montana, the monument was dedicated in honor of Laura Tolman Scott, a pioneer resident of the Dillon and Armstead areas. The bronze plaque had been removed from the lake area and will be placed in a shelterhouse on an overlook where it will add to the view of the mile-high lake. Another bronze plaque erected by the Montana Daughters of the American Revolution in commemoration of Sacajawea also will be placed in the shelterhouse. In 1915, the latter tablet was placed in a park in Armstead, now within the reservoir area.

Pioneer Road

Gold prospectors and settlers, coming from Fort Hall on the Oregon Trail, followed a pioneer road through Clark Canyon and the Beaverhead Valley to the gold fields and fertile mountain valleys of the basin. Part of the famous pioneer road which became a U.S. highway was traversing the site of the reservoir. The State of Montana Highway Commission relocated about 8 miles of the

This old canyon Ferry Village picture was shot 16 years ago by the National Park Service just before reservoir water covered the area. The buildings were constructed in the late 1890's.



highway. About 4 miles of the highway now will parallel the east shore of Clark Canyon Reservoir.

The Utah & Northern Railroad, from Corinne, Utah, was extended northward into Montana in 1880, and the town of Dillon was born. Named after the president of the railroad, Sidney Dillon, the new town became the county seat of Beaverhead County when voters decided the "Bannack was too far off the beaten track." This railroad laid the first tracks in Montana.

Since the railroad, now part of the Union Pacific system, was in the site of Clark Canyon Dam and Reservoir, a contract for the relocation of 15 miles of the railway to the edge of the site was completed in 1962. The buildings at Armstead, located on the railroad and at the junction of Prairie Horse Creek and Red Rock River, also were moved from the reservoir area. The Union Pacific under contract with the Bureau, has rebuilt the railroad depot, stockyards, and other facilities at the Red Rock relocation.

In about 1910 at the peak of railroad construction in the town, Armstead buildings included two grocery stores, a hotel, livery stable, and eight saloons. However, the population of about 200 persons had dropped by the middle 1950's to approximately 75.

Preparations for storing good mountain water behind a Bureau dam often requires removing trees, buildings, and facilities like Armstead, some items more valuable than others. But there is great potential in Canyon Ferry and Clark Canyon Dams and the huge water supply in their reservoirs. Canyon Ferry Lake is 25 miles long and 4½ miles wide; it holds a maximum capacity of water equivalent to 2,015,000 acres, 1 foot deep. Benefits of the project provide hydroelectric power, flood control, recreation, and fish and wildlife protection. The facilities were complete in 1954 and they provide water for irrigating many acres of rich Montana land.

Clark Canyon Dam, dedicated in September, and now essentially complete, is scheduled to release its first water for irrigation in early 1965.

These storage features in the Three Forks Division of Montana, and others planned to hold precious waters, are meticulously calculated by engineers, economists, and other specialists to provide valuable dividends of water for the present and future generations.

In carrying out the reservoir clearing job, the Bureau's investigations are detailed, moving any item is exacting, and quality is achieved in whatever reconstruction is necessary. # # #

LAST REPAYMENT CHECK IS AN OCCASION

In marking the end of an era, a check of final payment was made by the American Falls Reservoir District No. 2, Gooding, Idaho, on the Minidoka project for construction obligations by the Federal Government. This picture was taken on June 8, 1964, when Orval Nielson (not shown in the photo), president of the board of directors of the District No. 2, presented Regional Director H. T. Nelson (fourth from left) a check in the amount of $74,909.39 as final payment for the costs of American Falls Dam and Reservoir, the Milner-Gooding Canal, lateral system, and funded operation and maintenance associated with some 78,167 acres of the District's "old" and "river-right" lands in the Gooding Division of the Minidoka.

Among those present at the ceremony were two "oldtimers" in district affairs. Herbert Meyer (third from left), now 90 years old, came to Gooding in 1907 and homesteaded on land he still owns. He established his present hardware business in Gooding in 1908. As a young man he took part in the Oklahoma land rush. He has served on the board of directors since 1930.

Judge D. H. Sutphen and his brother (not shown in the photo) established law offices in Gooding in 1908. Judge Sutphen served as attorney for the water users in the formation of the district, and as attorney as well as secretary treasurer for the district until he was appointed to the district court bench in 1929. He retired as judge in 1960.

Others present are, at left, H. R. Gray, project superintendent of the Minidoka project, Idaho and Wyoming, and Lurlene Eastabrooks. At right are E. H. Neal, regional supervisor of irrigation, and Julius Schmidt.

In accepting the check from the president of the board, Mr. Nelson read congratulatory messages from Secretary of the Interior Stewart L. Udall and Reclamation Commissioner Floyd E. Dominy.

The Minidoka project in southern Idaho is one of the oldest and most successful Federal Reclamation projects in the West. It consists of several divisions constructed over the past 58 years. Although there were extreme shortages of water in the early days, today the district lands seldom experience a shortage. However, the earlier problems have not been forgotten and the district has indicated an interest in participating in future storage which may be developed in the Upper Snake River Valley. # # #

This July 11 photo shows what various properties were damaged in the Sun River Valley near Great Falls.

The Week the Rains Came

Several days of warm torrential rains falling on Montana mountains early last June gave ominous warning. The downpour drenched the heavily packed, late spring snows and ground on the slopes of the Continental Divide.

Tom Gibson was taking a look at the way the ground had absorbed all this moisture. It was a fateful June 9. As he raised his eyes in the direction of Swift Dam, he saw a wall of water forcing its way through the valley with a roar. The sight was frightening and sickening for Gibson. And it was the start of the most destructive flood in the history of Montana.

Assistant Supervisor Tom Gibson of the Pondera County Canal & Reservoir Co. was inspecting his company's irrigation works on the eastern slopes when it happened. The canal headworks were 9 miles below Swift Dam—a water storage facility on Birch Creek for supplying municipal water to the city of Conrad and irrigation water for more than 70,000 acres of land.

Said Gibson, "I figured that wall of water was 20 feet high because I saw it go over the top of a house. The house disappeared, came to the surface, went under again, then started to break up."

The building belonged to the irrigation company and was occupied by gatetender Tom Hall, Jr., and his family. In the home at the time the water struck were Hall's wife and seven children. They, along with a friend of the family visiting the Halls, were lost.

This scene was a part of the death and devastation that struck some of the most beautiful country in the United States.

Within a few hours of the Swift Dam tragedy, a similar scene was taking place in the Two Medi-

cine Creek Valley about 30 air-miles north. Here, nestled in the foothills where normally many families are working their farmland at this time of year, Lower Two Medicine Dam, an irrigation structure of the Blackfeet Indian irrigation project, washed out releasing the swollen waters of Two Medicine Creek on a wild rampage. Following the failure of Two Medicine Dam, eyewitnesses reported, the once vibrant and active valley was made bare and desolate. The only sign of life was a lonely riderless horse. The horse's foot was tangled in the stirrup of the saddle hanging upside-down under its belly.

Officials flying over the flooded areas reported that most of what could be seen constituted wide areas of destruction. Few signs of people were evident—those visible were helping others in distress. Buildings, toppled on their sides or roofs, were deep in mud and debris. Highways, which had looked like ribbons from the air, suddenly vanished below vast bodies of dark muddy water. Western Montana, in a matter of hours was described as having acquired a "war zone" look. These were dark days.

East and West of Divide

Thirteen counties—nine east of the Continental Divide and four west of the divide—were included in the disaster area. It caused serious destruction on the west slope's Flathead River Valley. East of the divide water overflowed the Sun, Teton, and Marias Rivers, tributaries of the Missouri.

The St. Mary River flowing north into Canada and the Hudson Bay was also affected.

Various agencies moved rapidly into distressed areas to cooperate and assist in providing emergency relief and to estimate the damage.

The Bureau of Reclamation, Corps of Engineers, and the Office of Emergency Planning, assisted State local officials in starting the gears of action to bring back to normal, as soon as possible, devastated areas. Commissioner of Reclamation Floyd E. Dominy and Indian Affairs Commissioner Philleo Nash went immediately to the scene from Washington while the floodwaters were still flowing. They made the trip in response to a request of Senator Mike Mansfield of Montana.

As the waters went down, estimated damages went up. First reports indicated \$6 million, \$8 million, then \$20 million. The Office of Emergency Planning, established to act in time of Federal disaster, finally set Montana's loss at \$62.61 million. About \$41 million of the damage was to private lands and facilities and \$21 million to public property.

The flood has been tabbed by the OEP as the seventh most serious disaster and the worst flood of 172 major disaster declarations since passage of the Disaster Act of 1953. Only this year's Alaska earthquake and the 1962 Guam typhoon exceeded the Federal financial assistance required.

There was no wonder that the deluge of water from the raging rivers and streams that swept across Montana had caused extensive damage to many structures and irrigation facilities. Although reclamation structures had greatly reduced probable flood harm by preventing millions of dollars in flood damage, many of its facilities had received severe blows.

The Bureau's Gibson Dam, the principal structure of the 91,000-acre Sun River project, was overtopped to a depth of 3.2 feet on June 8, the first time the dam had been overtopped since its completion in 1929. The dam, on the north fork of the Sun River, is 60 river-miles from Great Falls. A concrete structure, it was not damaged by overtopping.

Rough estimates indicate that the combined inflows of the north and south forks of the Sun River into Gibson Reservoir on June 8 and 9 were between 50,000 and 60,000 cubic feet per second and discharges from the reservoir were nearly as high. This was about five times the peak discharge at Gibson Dam during the 1953 flood.

Topsoil and loose rock on both abutments of Gibson Dam were eroded down to bedrock, the control house damaged, and the appurtenant facilities were filled with silt during the flood. The warehouse, the pumphouse and its contents, and the access bridge were washed away.

The 10,385-acre Fort Shaw Division of the Sun River project, operated by the Fort Shaw Irrigation District, received damage on its headworks, main canal, laterals, turnouts, checks, flumes, and siphons. The inventory of damage on the cost of Sun River project repair and rehabilitation of facilities was placed at \$635,000.

At the time of the flood, the water in Sherburne Lake on the Milk River project was at a low level, permitting it to trap the entire floodflow of Swift Current Creek and contributing greatly to downstream protection.

Floodflows of Kennedy Creek, a tributary of the St. Mary River, severely damaged the Ken-

Though not designed to pass water over the top as do some dams, Gibson Dam is shown with more than a foot of treacherous flood waters tumbling over its concrete rim. Coming around both ends of the dam, the flood washed soil and loose stones down to bedrock. The dam was constructed primarily for storage of Sun River waters, but with a structural safety bonus for such emergency situations. (Photo taken on June 9, 1964, by George F. Roskie, U.S. Forest Service.)

nedy Creek Siphon and reaches of the St. Mary Canal. More than 1 mile of the St. Mary Canal was eroded and several hundred acres of Government and private lands were covered with trees and debris. After the flood, Kennedy Creek was flowing in a newly formed channel through a breach in St. Mary Canal adjacent to the outlet of Kennedy Creek Siphon. The estimated cost of repair and rehabilitation of the Milk River project works is $265,000.

Bureau Assistance

The Bureau of Reclamation rapidly moved in by June 13 with concentrated plans to provide assistance to areas needing immediate attention. Even before the floodwaters had started to recede the Bureau had contractors moving equipment in to the areas to get the first phase of temporary rehabilitation underway. Crop losses were reduced as soon as possible and the job of getting irrigation water back on the farms was quickly tackled.

Immediate help was needed by the Fort Shaw, Greenfields Divisions of the Sun River project and St. Mary Divisions of the Milk River project both of which were federally constructed. The OEP also promptly requested the Bureau of Reclamation to rehabilitate and reconstruct the damaged works on non-Federal irrigation districts.

The road between Gibson and Sun River Diversion Dam was immediately repaired. Temporary bridges were thrown across Beaver Creek. Power and telephone services were restored.

As early as June 15 rehabilitation of the Fort Shaw Irrigation District began. It was a big job. Washed-out areas of canals had to be replaced. Laterals and canals choked with debris and silt had to be cleaned, but the job was sufficiently accomplished for immediate temporary use and water was being supplied in such rapid fashion that farmers who had been among the first to order water did not have their farm ditches in shape and ready to receive it by the time the Bureau had completed emergency cleanup and temporary restoration activities.

At Willow Creek and the Pishkun Feeder Canal, work was immediately begun to restore temporary service on the choked and washed-out canals.

Within a matter of a few weeks Kennedy Creek was back in its original channel and the feeder canal was restored to meet immediate requirements for water on the Milk River project.

The Greenfields and Fort Shaw irrigation districts of the Sun River project and the Malta and Glasgow Irrigation Districts of the Milk River project were determined by the Office of Emergency Planning as eligible for disaster relief assistance.

Repair work on facilities of the irrigation distribution system were initiated at once to the extent that limited delivery of irrigation water was possible by July 15 from Swift Reservoir which had been serving about 70,000 acres of land. Early in February 1965, it is anticipated that invitations will be issued to construct a new thin concrete-arch dam to replace the former rockfill Swift Dam.

The Bureau is rehabilitating and reconstructing the severely damaged works of the Bynum irrigation district in the Teton Basin. Emergency repairs to the irrigation distribution system were made at once so that irrigation could be resumed as soon as possible.

Survey parties were organized from Bureau offices in North and South Dakota, and the first topography for design purposes for a new Bynum Diversion Dam was submitted by August 3. Work will proceed on this structure during the winter. Completion is scheduled within 210 days following contract award and it will be ready by the time the 1965 irrigation season demands water.

Dates are Met

Immediately after the floods occurred, the Bureau of Indian Affairs requested that Reclamation construct a replacement for the Lower Two Medicine Dam. Target dates have been met and specifications for the construction of the new Two Medicine structure will be issued in early 1965.

On August 3 the Office of Emergency Planning requested the Bureau to provide assistance to the Brady irrigation district which serves about 5,000 acres of land for irrigation. The Bureau is at work in the restoration of the project. Diversion canal headworks at Muddy Creek must be backfilled, washouts and overtopped sections in the diversion canal must be repaired, and tons of silt deposits along 3½ miles of diversion and distribution canals must be removed. Work on the Brady system will be completed as this publication is printed.

Federal multiple-purpose reservoirs in Montana prevented millions of dollars in damages during the June floods. Speaking before a special House Public Works Subcommittee in Washington, August 5, Reclamation Commissioner Floyd E. Dominy pointed out that Hungry Horse Reservoir, west of the divide, was responsible for averting more than $10 million of flood damages and Tiber Reservoir, on the Marias River, and Canyon Ferry Reservoir, on the Missouri River, substantially reduced probable losses. The special subcommittee had visited the flood-wracked area in Montana in June.

By controlling the releases of water from Tiber Dam, the town of Loma and the structures in the Marias Valley were saved.

Canyon Ferry Dam and Reservoir on the Missouri River, 17 miles from Helena, also did yeoman service in alleviating flood conditions in Great Falls.

The combined flows of the Missouri River and Sun River at Great Falls were reduced from 94,00[illegible] cubic feet per second to 77,400 cubic feet per second, by storage of nearly 170,000 acre-feet of flood runoff in Canyon Ferry Lake—almost completely utilizing the available storage space.

Although from an engineering viewpoint, Gibson performed flawlessly, it dramatically pointed out that more upstream control than that provided by it is required to adequately control the floodflow of the Sun River and its tributaries.

During the brief period since the flood, recover

Ray Thomas of West Great Falls, Mont., goes by boat on July 10 to inspect his home. Water had risen to the ceilings of many homes in this area.

has been rapid and much has been accomplished to effect emergency repair and temporary rehabilitation. However, much remains to be done. The Bureau, charged with the bulk of the responsibility and work in the permanent restoration of water retention facilities and rehabilitation of irrigation works, has established a construction office at Conrad, Mont. It will supervise rebuilding of the three dams destroyed by the disastrous floods.

To be rebuilt are Bynum Diversion Dam, Swift Dam, and Two Medicine Dam; and to be rehabilitated is the private Brady Irrigation District on Bynum Irrigation District distribution system.

Rehabilitation of operating Federal projects which will require reconstruction of a section of the St. Mary's Canal, repairs on Gibson Dam, Fort Shaw and Greenfields division, and the cleanup of Tiber Dam, will be performed by the Bureau's Upper Missouri projects office at Great Falls, Mont.

Overall, the Bureau has been charged with the tremendous task of reconstruction or rehabilitation amounting to nearly $12 million, largely disaster relief funds appropriated by the Congress.

Although repairs are underway, the question of future floods occurring looms large. The Bureau of Reclamation has embarked on a program of investigations toward greater upstream control of major tributaries.

Joint studies betwen the Bureau and other Federal and State agencies will bring up to date the earlier studies to evaluate the construction needed. These proposals brought together will provide protection for the people who live in the valleys, and will bring an eventual solution and assurance that the flood of June 1964 will not be repeated. # # #

Algae Controlled in Measuring Devices

The growth of algae, greenish stoneworts, or scum which forms in canals, has long been a problem on water measuring devices. Arthur W. Thomas, of the Fresno Field Division, Central Valley Project, Calif., suggested the erection of a sunshade device over the throat of a Parshall-Type flume on the CVP.

In past years, it had been impossible to obtain a stable discharge rating, due to varying algae growth which affected velocity in the flume. Ten planks size 2 by 12 inches, by 14 feet, were scabbed together and laid over the throat of the flume. With the planks providing sufficient shade to make algae growth negligible, the rating remained constant during the 1963 season.

The cover is strong enough for occasional foot traffic, and heavy enough that it is not likely to be disturbed. This method of shading may be applied to other flumes or weirs where algae are a problem.

(Reprinted from *Operation and Maintenance Equipment and Procedures*, Release No. 48)

Renewing the Challenge to Water Safety

During 1963, public use of Reclamation lakes and reservoirs for enjoyment of water sports such as boating, swimming, and fishing exceeded an estimated 14.6 million visitor-days. In the past, providing for the safety of those enjoying these recreational areas challenged the ingenuity of the Bureau of Reclamation. The challenge was only partially met by providing for safety in the design and operation of these facilities. The single most important need was for an educational program, enjoying the support and participation of the communities adjacent to these projects.

Operation Westwide, *a program dedicated to reducing danger of drowning through a program of public awareness and active community participation, has exceeded even our most optimistic hopes in fulfilling this need.*

Jointly sponsored by the American Red Cross and the Bureau of Reclamation, Operation Westwide *was conceived in July 1958 with the organization of the Yakima Valley Safety Council, Yakima, Wash. Today, there are 27 community water-safety councils actively working to "waterproof" the public in recreation areas throughout the West.*

Reclamation is indeed pleased with its partnership with the American Red Cross and the public, and is pledged to the safer enjoyment of its numerous lakes and reservoirs.
—Floyd E. Dominy, *Commissioner.*

Skydivers landing in the water was a real crowd pleaser. They are Daryl Galloway, Ogden; Lynda Hanson, student at Utah State University; and Jack Minnoch, Ogden, all of the Sigma Sky Divers' Club.

5,000 People Enjoy a Water Carnival as . . .

OPERATION WESTWIDE TAKES ACTION

by ROBERT W. CAREY and HAROLD E. DEAN

(Mr. Cary was Safety Officer at Salt Lake City, Utah, when this article was written; recently has taken the same post at Sacramento, Calif. Mr. Dean is Weber Basin Project Safety Engineer.)

More vacation and leisure time, higher incomes, more water surface—lakes and reservoirs—have been combined to create a recreational resource few people visualized a short time ago. Boats and people are covering water areas that once was land, creating water-based recreation and business opportunities in new areas of development.

The Bureau of Reclamation and others have recognized a growing problem in water safety, and have united to solve the problem with a program of organization and education. It is called Operation Westwide.

A festive air, a holiday atmosphere, a picturesque mountain lake and its gently sloping beach swarming with spectators enjoying a water safety show—this is Operation Westwide in action.

Five thousand people are watching amazing events. A group of skydivers plummeting 8,000 feet before opening their parachutes, float gently into a blue lake—are rescued moments later by the skilled men of the boat patrol. A daring young water skier hanging onto a big kite is being lifted into the air as his towing boat speeds past the audience. Expert American Red Cross instructors demonstrating survival methods—for example, a canoe dumps its occupants into dangerous waters, a fisherman loses his footing in a deep hole while wading out to catch that "big one."

The announcer uses a loudspeaker to explain demonstrations to spectators.

A scuba diving club demonstrating the safety aspects of their hobby; two "Resusci-Annes" (practice dummies for artificial respiration) being used by the public to learn the mouth-to-mouth method of respiration—not just watching a demonstration; continuous showing of water safety movies in the shade of a large tent. The Forest Service, the Coast Guard Auxiliary, the State boating division, the Cache County Water Safety Council of Logan, Utah, all plugging safety messages.

Now, add a carnival atmosphere of boat dealers showing their newest boats, motors, and equipment, and giving free rides to children and adults alike; refreshment stand operators struggling to make hamburgers fast enough to keep up with the demand; two Boy Scout troops, in uniform, keeping the grounds cleaned up in an effective safety, and antilitterbug campaign.

Fit this picture into a warm weekend during May 1964 at the beautiful Pineview Reservior in the mountains just 7 miles from Ogden, Utah, and you have the area's first Boat Show and Water Safety Carnival. It was sponsored by the Weber County Sheriff's Boat Patrol and the Bonneville Water Safety Council of Ogden.

How It Started

The idea of combining a Boat Show and a Water Safety Carnival and having it at Pineview came up in a meeting of the Boat Patrol to which coauthor Dean was invited. The show and carnival would have to be held early in the season for the boat dealers to be interested in backing it financially, yet late enough to have good weather. (It couldn't have been timed better. May 16 and 17 turned out to be one of the few nice weekends in a very wet spring.) Dealers were required to pay the costs of newspaper advertising for the privilege of displaying their boats and other equipment. The public was charged $1 per car to defray expenses and to buy first-aid equipment and supplies for use by the Boat Patrol in their voluntary work at Pineview.

Advertising was a major consideration, but pleasant cooperation was received. The Ogden *Standard Examiner* published articles and photographs. The State boating division passed out an announcement of the show with each boating license issued throughout the State. Salt Lake City's three television stations included announcements and interviews on their sports news broad-

casts, and several radio stations announced the show frequently. This publicity undoubtedly carried a safety message to many thousands of people who did not actually attend the Boat Show and Water Safety Carnival.

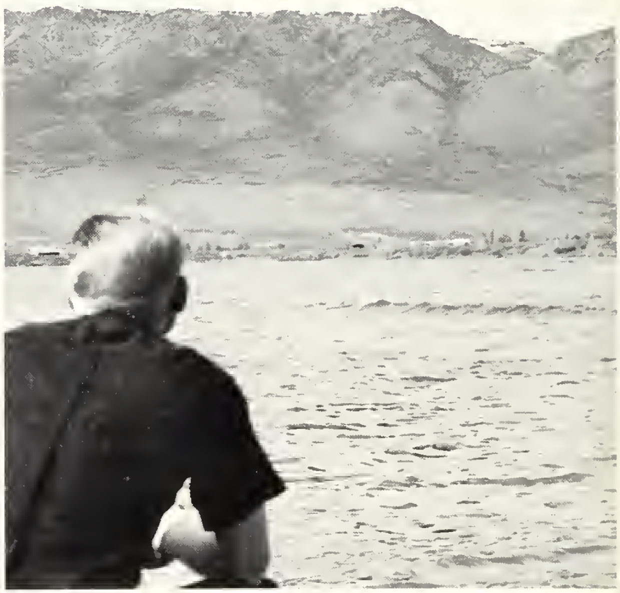
Utah's Governor George D. Clyde issued a formal statement on water safety and asked the citizens of the State to support the show. Governor Clyde said:

As we start another summer season, I urge all citizens to give careful consideration to the dangers involved in water sports. I urge all parents to be more watchful of their children wherever there is danger of drowning. I urge boaters, water skiers, swimmers, and other water sports enthusiasts to learn and adopt safe practices. Let courtesy and safety govern all our actions in the coming water sports season.

How It Went

The prevailing opinion was that the show was a big success. The spectacular events—the Skydivers and the Kite Man—did much to bring out the crowd. The demonstrations of survival methods and safety in scuba diving were dramatic enough to hold the crowd's attention and teach something worth while at the same time. The two practice dummies were busy most of the time as young and old gathered around and actually practiced mouth-to-mouth respiration. The Desert Diving Club, which demonstrated safety in scuba diving, also had a very attractive booth with equipment on display and trained people to answer questions. The Coast Guard Auxiliary had a booth and boat safety literature which was freely distributed. The boating division of the State parks and recreation commission had a fully equipped boat at the dock as a demonstration of what is required and what is recommended in the way of safety equipment. In addition to keeping the area policed, the Boy Scouts displayed a number of antilitterbug posters. And the Forest Service featured an animated, talking Smokey the Bear. Local merchants' displays attracted many, but their most popular item were the free boat rides for everyone. All physical arrangements were handled by the Sheriff's Boat Patrol. But the patrolmen's wives operating the refreshment stand were the busiest people on the lot.

To enable the interested spectators to enjoy the movies, and to visit and participate in the exhibitions, an announcer on a public address system kept the crowd informed of the various activities. The



The Flying Kite pulled by a boat provided thrills—and almost a spill. Man in the air is Dell Thredgold.

announcer was a specialist in all phases of water safety, and his description of the events increased interest and effectiveness even for those who took time out to walk along the beach. Between announcements, recorded music added to the carnival atmosphere.

The Bureau of Reclamation's direct participation was the continuous showing of water safety movies. The films included: "Teaching Johnny to Swim," "People Afloat," "Water Rescue," "Rescue Breathing," and "Be Water Wise."

It seemed that water-safety education was surely in action on those 2 days at Pineview, and plans are underway for a show like it next year—entertainment, water, and safety in Operation Westwide.

Two Water Safety Councils Operating

In the interest of water safety, two new organizations have made commendable starts to fulfill the need for educational programs in their respective areas in Utah. This need is defined by Commissioner Dominy in his comment preceding the article " 'Operation Westwide' Takes Action."

Council in Cache County

The Cache County Water Safety Council at Logan, Utah, was the first such organization to form in the Bureau of Reclamation's Region 4, headquartered at Salt Lake City, Utah.

During the Region's 10th Annual Safety Conference for 1962 held at Flaming Gorge Dam, Safety Engineer Bill Durrant of the Logan Development office responded to a call by the Regional Safety Officer for action on Operation Westwide. With the help of representatives from the Red Cross in Cache Valley and other interested citizens of the city of Logan, the Cache County Water Safety Council was formed. After officers and committee chairmen were elected, bylaws were drawn to cover the council's activities. This well-defined action, even at this stage, may have been unprecedented in the history of Operation Westwide. The bylaws have been most helpful in defining the purpose, duties, and responsibilities of the council officers and members.

Through the work of council members, weekly articles soon appeared in the Logan Herald Journal in a column entitled, "Aqua-notes." Other promotions included the use of water safety films in the county schools, Logan clubs, and civic groups. The Council also supported a proposal to construct a Logan City Municipal Pool, and helped the Red Cross in the instruction of more than 2,000 persons a year in swimming and lifesaving. Influence was used to reduce water hazards throughout the entire valley, by the use of water safety announcements and panel discussions on radio and television, safety poster and slogan contests in schools and clubs, encouragement of the enactment of desirable water safety legislation, and other activities.

Bonneville Council

The water safety program in the area of Ogden, Weber County, started slowly—people seemed unwilling to participate, problems were many.

Gradually, however, developments began. The State legislature passed a boating law and set up a boating division in the State park and recreation commission to administer the law. The sheriff of Weber County organized a boat patrol to help enforce the law at Pineview Reservoir.

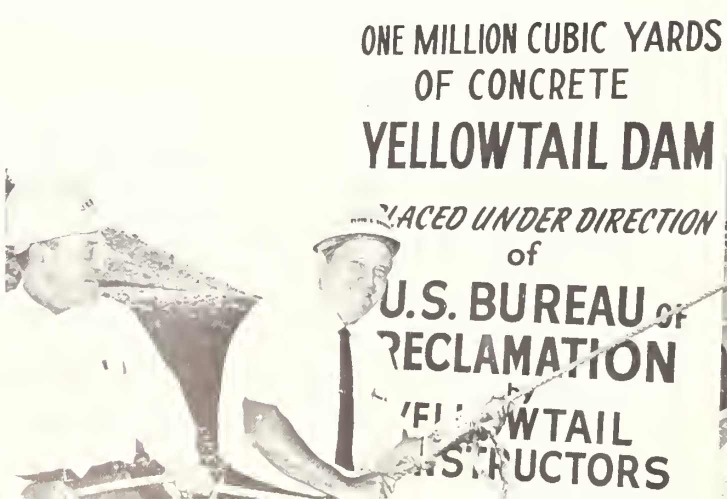
In the spring of 1963, the first formal meeting of the Bonneville Water Safety Council was held. Leadership was assumed by J. W. Hatch, a local banker, and the Safety Engineer, Mr. Dean. In the election of officers, Mr. Hatch was made chairman and Mr. Dean, secretary. Also two vice presidents and several committee chairmen were added.

An Ogden City judge drafted a set of bylaws, based to some extent on the Cache County Council's bylaws.

Twenty-two organizations have been participating actively in the Bonneville Water Safety Council. Although starting later than the safety organization for Cache County, the Bonneville Water Safety Council has been able to accomplish meritorious objectives in its first year. A good start was made toward promotion of community interest and activity in the field of boating safety, swimming safety, and canal safety. Perhaps, most of all, it has generated push and a measure of public education and awareness which culminated in the recent Boat Show and Water Safety Carnival.

# # #

A Reclamation Milestone—Commissioner Floyd E. Dominy is shown in the photograph as he pulls the trip rope to release the millionth cubic yard of concrete into Yellowtail Dam, Mont., at a public open house held August 15. Backing up the Commissioner in the rope tugging is J. B. Bonny, president of Morrison-Knudsen Co., Boise, Idaho, contractor for building Yellowtail—the 27th Bureau dam to be built as part of the Missouri River Basin project.



About a Farm Family in the Columbia Basin . . .

WHAT HAPPENED TO THOSE VETERANS?

by PAUL HAMILTON, Field Secretary, Columbia Basin Commission

A certain Congressman, many years a member of the House Appropriations Committee of Congress, perennially asks the question when Columbia Basin project apropriations are being discussed, "How are those veterans doing out there?"

Mr. Congressman, those veterans are doing right fine, thank you, and I'd just like to tell you about one that will justify the faith you have shown in the project through the years—in fact, I think he would want to thank you himself, given the opportunity.

This story has its beginning near Hamilton, Mont. Returning from the Pacific theater of World War II, Howard Knopp married onetime farm girl June Wienke and settled down on his father's 90-acre irrigated farm in the Bitterroot Valley.

"This was not what we were looking for," Knopp recalled. "Above all we wanted a place of our own, and we could not afford the price we would have to pay for a developed farm there in the valley. Then we heard about the Columbia Basin project and were immediately attracted to the idea of farming new ground with an up-to-date irrigation system."

Hearing about the Government and railroad land that might be available under the Veterans Preference Act, the Knopps applied and eventually ended up with a 70-acre unit in block 40 near Moses Lake purchased from the Northern Pacific Railroad.

"It was a tough decision to make," June Knopp added. "It took a lot of courage and soul searching to leave relative comfort behind to take on a field of sagebrush and face the unknown.

"I guess ours was a typical start in those days," Knopp recalled. "We had a few dollars, an assortment of old farm machines, a little raw land, a couple of youngsters to feed, and each other." But talking to the Knopps, you soon realize they had something else—they liked to farm, they knew how to farm—Howard had been on a farm since he was 4 years old—and they had a tremendous desire to make it go.

"I'll never forget that fall in 1952 when we were trying to get a roof over our heads," June related, "Howard and a friend were pouring a concrete floor in a chicken coop for temporary living quarters while I was trying to keep everybody warm with an open fire nearby. When we finally moved in with our two little ones that winter, that 16 x 26 chicken coop was like a palace."

Better things were to come though. The next year they were able to arrange long-term FHA financing that built them a two-bedroom home—since added on to twice—a milk parlor, 20- x 60-foot machine shed, and a well, pump, and pump-house for their domestic water supply. And then something happened that nearly did them in.

In 1953, Howard had "an understanding" with a dairy firm that they would buy his milk if he brought out his small dairy herd he had left in Montana, and on this premise the milk parlor was built.

"The idea of a regular milk check appealed to me," Knopp said. "So we hauled out the herd from Montana and started milking." Only then, it developed, the promised market had vanished.

"We milked all one summer, dumping milk down an old cistern before we got rid of the herd. We suffered a $4,000 loss on that deal which was hard to take," he recalled, and added with a smile, "No more of that—we've got a family cow now and that's enough."

Best Money Crop

Despite poor production last year, alfalfa seed has been their best money crop, followed by irrigated pasture that maintains 40 to 60 head of feeders, alfalfa hay, grain, and beans. They had sugarbeets for 3 years and Howard helped his income by working in the U & I plant during the winter months. But their soil wasn't "right" for good beet production, and so beets are no longer included in their program.

"We're a family operation," Knopp said. "June worked out, too, at a local office during some of those real lean years."

The Knopps farm is about 290 acres today. They bought 40 acres to add to their home place a few years ago, and lease another 180 nearby.

Today they live in a modern 1,700-square-foot home completely equipped from telephone to freezer. Their farm buildings consist of the 27 x 48 former milk parlor, now used as a utility shed, the chicken coop now complete with chickens, and a 26- x 60-foot frame machine shed. There is an air of neatness about the place, a small orchard on one side of an attractive, well-kept front yard, rows of decorative pine trees on the other. Back of the house, corrals, well-kept farm buildings and equipment, and shiny storage bins complete a peaceful farm picture.

A good indication of their progress is their own statement, "We've got just about everything paid for with the exception of a small home loan." Their crop production is financed by bank loans plus whatever resources they have available themselves.

Success for the Knopps has not been without a lot of hard work and basic resourcefulness.

"We do most all of our own canning, use fruit from our own trees," June pointed out, "and I bake pies and cakes and sometimes our own bread. We have our own fryers and eggs, a freezer stocked with our own beef, our own milk and sometimes butter."

Although recovering from a serious back operation performed last November, June Knopp has a ready smile, and successfully manages the active lives of sons Ronnie, age 16; Rickie, 14; Randy, 8; and Rusty, 6—"Oh, well, I never like to sew ruffles anyway," was her only comment about the all male crew. It's June, too, who keeps the family active in the First Baptist Church in nearby Moses Lake.

The older boys have projects of their own—Ronnie's is 15 bee hives complete with honey extracting equipment, and Rickie's a fat calf as a 4–H Club project. Ronnie about paid for his investment last year, his Dad was proud to report.

What do the Knopps think about the Columbia Basin project?

"For a family area, I think it's about as good as you can find—mild winters, long growing season. We could always use better prices, we have to cut it kind of close at times, but I guess that's true in any area," was Howard's reply.

June's comment: "We done real well and have had hard times and good times. We have good neighbors. They are all wonderful people." June has been active in the local women's club, the Gloydettes, and both have enjoyed the social activity centered around the Block 40 Club. Both reflect the pioneer spirit that has prevailed in the Basin, its people drawn together by the common problems of a new farm area.

The project builders, the U.S. Bureau of Reclamation, testified before Congress last year that over 80 percent of the 1,031 veterans who had purchased Government land under the preference act handled by the Bureau were still on the project.

Considering the total dollars these farmers have funneled from the marketplace to the suppliers of building materials, farm equipment, furniture, appliances, medicine, fertilizers, ad infinitum, the economic impact of the veteran preference program is staggering—opportunities not only for the veterans, but opportunities many times their number all over the land. # # #

(This article from the *Spokesman Review* of April 26, 1964, Spokane, Wash., was reprinted by permission of author Hamilton.)

Howard Knopp feeds 60 head on basin farm.

STAMM AND MERMEL APPOINTED COMMISSIONER'S AIDES

Mr. Stamm.

Mr. Mermel.

Permanent appointment of Gilbert G. Stamm as Assistant Commissioner, Legislation and Coordination, and T. W. Mermel as Assistant to the Commissioner—Research, was effective in early August. Both Mr. Stamm and Mr. Mermel have been serving in acting front office capacities since early March.

G. G. Stamm—Mr. Stamm's appointment fills the vacancy left by William I. Palmer who resigned on May 2. Mr. Stamm will continue in the position of Acting Assistant Commissioner—Planning and Irrigation, to which he was appointed when he left the job of Chief, Division of Irrigation and Land Use, in March.

A native of Denver, Colo., Mr. Stamm has been engaged in Federal resources development programs since 1936, a year after his graduation from Colorado State University with a B.S. degree in agriculture economics.

He had been an employee of the Department of Agriculture for 8 years prior to his joining the Bureau in 1945. One of his early Reclamation assignments was Assistant Regional Operation and Maintenance Supervisor in Region 1.

In 1954 Mr. Stamm was assigned Superintendent of the Central Snake Project Office, Boise, Idaho, and the next year was promoted to the position of Associate Regional Supervisor of Irrigation while still retaining his Project Superintendent duties. In early 1958, Mr. Stamm was appointed Regional Supervisor of Irrigation and in December of the same year was reassigned to the post of Assistant Regional Director of Region 1. He was named Chief, Division of Irrigation and Land Use, in Washington in August 1959. Mr. Stamm is a member of the Executive Committee of the U.S. Committee, International Commission on Irrigation and Drainage.

In 1952 and 1956, Mr. Stamm received Superior Accomplishment Awards, and in October 1963 was the first Bureau employee to receive the newly authorized quality increase in salary.

T. W. Mermel—In addition to his new post, named above, Mr. Mermel will continue to serve as Chief, Division of General Engineering.

Mr. Mermel is a native of Chicago, Ill., and is a Federal career employee of more than 30 years with the Bureau. He was awarded a B.S. degree in electrical engineering from the University of Illinois.

Coming to Washington after graduating, Mr. Mermel first began his Federal employment with the Interstate Commerce Commission. He started with the Bureau of Reclamation in 1933 at the Office of Chief Engineer in Denver, Colo. After 8 years with Denver's design and research center, he transferred to the Washington office where he has served for 21 years in engineering leadership and liaison for the Bureau.

He is a registered professional engineer and has maintained wide and active interest in new technical developments in the water resources field through his activities in various related organizations including the U.S. Committee on Large Dams, International Commission on Irrigation and Drainage, World Power Conference, American Society of Civil Engineers, and the Institute of Electrical Electronics Engineers.

Mr. Mermel also has taken graduate studies at George Washington University and at the University of Colorado. He is chairman of the International Committee on the World Register of Dams and is author of *Register of Dams in the United States*.

In establishing the new position, Assistant to the Commissioner—Research, recognition is given to the growing importance of water conservation research in the Bureau's overall program. Mr. Mermel will coordinate the Bureau's widespread

efforts to devise new and improved methods of meeting the continually increasing water supply problems of the 17 Western States.

Two New Division Chiefs Named

Maurice N. Langley was appointed Chief, Division of Irrigation and Land Use, on August 19, to fill the vacancy created by the advancement of Mr. Stamm. He had been Mr. Stamm's Assistant Chief of the division since May 1962. A native of Dorchester, Nebr., and raised in Otis, Colo., Mr. Langley joined the Bureau at Yuma, Ariz., in 1946. He was Chief of Operations at the Yuma Projects Office prior to transfer to Washington in January 1959. In December of that year, he was promoted to the position of Chief, Irrigation Branch. His membership in professional societies includes the American Society of Agriculture Engineers, American Society of Soil Science, the International Commission on Irrigation and Drainage, and the International Society of Soil Science.

William H. Keating was appointed Chief, Division of Power, in July, succeeding John W. Mueller who transferred to the Regional office at Salt Lake City, Utah.

Keating, a 15-year veteran career employee and native of Trenton, Mo., joined the Bureau's staff at the North Platte River District Office at Casper, Wyo., shortly after graduation in mid-1949 from the University of Missouri. After an assignment at the Denver, Colo., Regional Office, he was made Chief, Power Contract and Marketing Branch, at the Sacramento office. He became Assistant Regional Supervisor of Power at the latter office in May 1962. # # #

Shown in the photo from the left are Reclamation Commissioner Floyd E. Dominy, Secretary of the Interior Stewart L. Udall, and Vice President J. Sharp Queener, of the National Safety Council.

Two Highest Awards for the Bureau

The Award of Honor, highest recognition given by the National Safety Council, was presented to the Bureau on June 24 in recognition of its excellent safety record—a 66-percent improvement.

Presentation of the inscribed Award of Honor plaque was made to Commissioner of Reclamation Floyd E. Dominy by J. Sharp Queener, vice president of the National Safety Council. Secretary of the Interior Stewart L. Udall was present at the ceremony which was held in his office.

Also, an Interior Award Committee, after reviewing data submitted for consideration of the Department's 1963 Safety Award in competition with other bureaus and offices, selected Reclamation for the annual Department laurel. Reclamation's 1963 frequency rate of 4.5 disabling injuries per million man-hours worked is the Bureau's lowest, and marked the third consecutive year that an improvement was recorded over the preceding year. In 1962 the rate was 5.2, and in 1961 it was 7.6. # # #

ALASKA. (*Continued from page 82*)

tailrace, and reconstruction of the gate section of Old Eklutna Dam, built by private interests about 1929, which was rendered unsafe by the quake. These permanent repairs are programmed for completion by the fall of 1966.

The cost of repairs to date and the estimated cost of the balance of the work, including permanent repairs, are now estimated at nearly $4 million. This is a sharp financial blow to this little project, which had developed a fine financial record in its first 9 years of operation. Up to the time of the quake, the payout of the project at present rates was scheduled to occur 9 years earlier than the 50-year period normally adopted for such projects. If the total costs are to be reimbursed by the purchasers of the power, the present rates will now be no more than sufficient to return all costs to the treasury with interest in 50 years.

The Alaska earthquake was registered as a wracking 8.6 on the Richter-Guttenberg scale—comparable in magnitude to the San Francisco quake in 1906 and other great disasters. While this huge force of nature was devastating, there was one measure of satisfaction—to quote from the Powerplant operator's report:

> I believe that the extra effort the Bureau of Reclamation put forth in designing and building these structures, so that they would be as earthquake proof as possible, paid off. Without it, this project would probably have been damaged beyond repair. # # #

MAJOR RECENT CONTRACT AWARDS

Specification No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-6100	Colorado River Storage, Ariz.	July 9	Construction of the 124-mile Glen Canyon-Flagstaff 345-kv transmission line No. 2.	Ets-Hokin Corp., San Francisco, Calif.	$6,314,816
DC-6110	Fryingpan-Arkansas Colo.	July 15	Construction of Ruedi Dam	Puget Sound Bridge and Dry Dock Co., Seattle, Wash.	10,477,886
DS-6117	Colorado River Storage, Ariz.	July 9	Four 345-kv power circuit breakers for Flagstaff substation	Westinghouse Electric Corp., Denver, Colo.	728,645
DS-6119	Missouri River Basin, Mont.	July 15	Three 26,000/34,667/43,333-kva autotransformers for Yellowtail switchyard.	General Electric Co., Denver, Colo.	229,343
DC-6120	Silt, Colo	Aug. 1 (Sat.)	Construction of Rifle Gap Dam and road relocation	Northwestern Engineering Co., Commerce City, Colo.	2,727,178
DC-6126	Missouri River Basin, Wyo.	July 31	Construction of Lyman substation, stage 01; and 4.51 miles of Lyman taplines.	Reiman-Wuerth Co., Cheyenne, Wyo.	278,930
DS-6127	Colorado River Storage, Ariz.	Aug. 11	One 450,000/600,000-kva autotransformer for Pinnacle Peak substation.	Westinghouse Electric Corp., Denver, Colo.	550,484
DC-6129	Central Valley, Calif	do	Construction of flood bypass for Red Bluff diversion dam	Talbot D. Bailey, Inc., Oakland, Calif.	112,153
DC-6130	Canadian River, Tex	Aug. 13	Construction of 140 miles of pipelines for Main aqueduct (Lubbock to Lamesa), Southwest aqueduct and pumping plants No. 8, 9, 10, and 11.	R. H. Fulton, Contractor, Lubbock, Tex.	8,785,519
DC-6134	Missouri River Basin, S. Dak.	Aug. 24	Construction of the 18.8-mile New Underwood-Rapid City 115-kv transmission line No. 2 and extensions to Rapid City-Midland 115-kv transmission line.	Malcolm W. Larson Contracting Co., Denver, Colo.	236,709
DS-6137	Central Valley, Calif	Aug. 25	Seven 63,000/84,000/105,000-kva power transformers for San Luis pumping-generating plant and Mile 18 pumping plant.	General Electric Co., Denver, Colo.	1,345,716
DC-6139	Missouri River Basin, Nebr.	Aug. 20	Construction of Dunlap substation, stage 01	C.S.P. Engineering Co., Casper, Wyo.	129,336
DS-6142	Missouri River Basin, Mont.	Sept. 9	Four 230-kv and four 115-kv power circuit breakers for Yellowtail switchyard, Schedules 1 and 2.	McGraw-Edison Co., Pennsylvania Transformer Division, Canonsburg, Pa.	337,631
DC-6143	Missouri River Basin, Kans.	Sept. 25	Construction of Downs protective dike, Sta. 11+64 to 44+15	Alexander Construction Co., Inc., Littleton, Colo.	414,581
DS-6144	Missouri River Basin, Mont.	do	Six 51,000-kva power transformers for Yellowtail powerplant	Westinghouse Electric Corp., Denver, Colo.	497,196
DC-6155	Teton River Mont	Sept. 4	Reconstruction of Bynum diversion dam, Teton Co-Operative Reservoir Co. (Negotiated contract).	A & B Construction Co., Helena, Mont.	430,655
200C-562	Central Valley, Calif	Sept. 3	Removal of existing timber bridges and rehabilitation of 37 timber bridges along Delta-Mendota canal between Mile 3.50 to 70.01.	Murphy Pacific Corp., Oakland, Calif.	613,430
200C-563	do	do	Rehabilitation of nine timber bridges along Friant-Kern canal between Mile 4.12 and 111.32.	Kaweah Construction Co., Visalia, Calif.	117,058
400C-267	Colorado River Storage, Colo.	Sept. 11	Construction of machine shop and service garage for Montrose power operations center.	H. E. Whitlock, Inc., Pueblo, Colo.	552,172
400C-270	Central Utah, Utah	Sept. 10	Construction of 1.75 miles of earth lining, riprap protection, and miscellaneous structures for Steinaker service canal, High Line canal, and Fort Thornburgh diversion dam.	United Engineers, Inc., Salt Lake City, Utah.	157,693

Major Construction and Materials for Which Bids Will Be Requested Through November 1964*

Project	Description of work or material
Bureau of Reclamation Denver, Colo.	Constructing a 14-story (including basement), 110- by 210-ft office building, a lightweight prestressed and poststressed concrete structure with movable partitions; concrete floors with vinyl asbestos, ceramic, quarry tile, and terrazzo floor covering; aluminum frame windows; metal and wood doors; built-up tar and gravel roofing; and concrete caisson foundations. Work will include complete lighting system; electric power system; complete plumbing system; heating and air-conditioning system (steam heat will be provided from an existing plant); five-passenger elevators and one freight elevator; and cafeteria space in basement. Chief Engineer's Office, Denver Federal Center near Denver.
Arbuckle, Okla	Four 3-ft by 6-ft 6-in. high-pressure gate valves; and two 2-ft 9-in. by 2-ft 9-in. high-pressure gate valves for the Arbuckle Dam. Estimated weight: 180,000 lb.
Canadian River, Tex	Constructing about 34 miles of 20- to 36-in.-diameter pipeline for hydrostatic heads of from 25 to 500 ft. pipe to be either reinforced-concrete pressure pipe, pretensioned concrete steel-cylinder-type pipe, noncylinder prestressed concrete pipe, steel pipe or asbestor-cement pipe. Work will also include excavating a 34-acre-ft reservoir to be lined with compacted earth lining, and constructing two pumping plants of about 24- and 14-cfs capacities. East Aqueduct, near Borger and Pampa.
Central Valley, Calif	Constructing about 30 miles of 10- to 54-in.-diameter pipelines and a steel tank. Pipelines are to be constructed of either noncylinder prestressed concrete pipe, pretensioned steel-sylinder concrete pipe, steel pipe, or asbestos-cement pipe. Cow Creek Unit, near Redding.
Do	Completion work for the San Luis Pumping-Generating Plant will consist of placing concrete for pump-turbine embedment and motor-generator support; installing eight 2-speed, vertical-shaft, hydraulic pump-turbines rated at 63,000 hp at 150 rpm and 34,000 hp at 120 rpm, transformer bank, and other mechanical and electrical equipment; and applying architectural finishes. Completion work for the service yard will require final grading and surfacing. Constructing the San Luis Switchyard will consist of constructing concrete foundations; constructing a 38- by 62-ft brick veneered concrete masonry unit control building; furnishing and erecting steel structures; installing eight 230-kv circuit breakers, and associated electrical equipment, major items of which will be Government furnished; and surfacing and fencing the area. Constructing the Forebay Switchyard will consist of constructing concrete foundations; furnishing and erecting steel structures; installing four single-phase, 10,000-kva, 70-4.16-kv transformers and one 69-kv circuit breaker, and associated electrical equipment, major items of which will be Government furnished; and surfacing and fencing the area. Near Los Banos.

U.S. GOVERNMENT PRINTING OFFICE : 1964 O—743-007

Major Construction and Materials for Which Bids Will Be Requested Through November 1964*—Continued

Project	Description of work or material
Central Valley Calif	Earthwork and concrete for raising the concrete lining about 18 inches on about 66 miles of the Delta-Mendota Canal and modifying turnouts, drainage inlets, checks, siphon transitions, etc. From near Tracy to near Los Banos.
Do	Constructing Little Panoche Creek Detention Dam and appurtenant features. The dam will be about 120 ft high, 1,440 ft long, and will contain about 1,100,000 cu yd of earthfill. The outlet works will be an uncontrolled conduit near stream level and the spillway an uncontrolled glory-hole-type structure. On Little Panoche Creek, about 18 miles southwest of Firebaugh.
Do	Constructing about 1,900 lin ft of 80-ft bottom width San Luis Forebay Intake Channel which will be lined with 4-in.-thick unreinforced concrete; constructing about 2,200 lin ft of relocated Delta-Mendota Canal with bottom width of 48 ft, lined with 4-in.-thick unreinforced concrete; and constructing about 3,500 lin ft of Forebay Dam Wasteway Channel with bottom width of 120 ft, including a reinforced-concrete baffled apron drop and a reinforced-concrete culvert drop under the Delta-Mendota Canal. Near Los Banos.
Do	Constructing about 8 miles of 42- and 45-in.-diameter pipeline for hydrostatic heads of from 200 to 600 ft. Pipelines are to be constructed of either noncylinder prestressed concrete pipe, pretensioned steel-cylinder concrete pipe or steel pipe. Work will also include constructing one steel tank 30 ft in diameter and 50 ft high. Clear Creek South Pipelines, near Redding.
Do	Constructing about 63 miles of 6- to 48-in.-diameter pipelines of either reinforced-concrete pressure pipe or asbestos-cement pipe. Work will also include excavating two small reservoirs and constructing nine steel tanks and six pumping plants ranging from 23.5- to 80-cfs capacity. Corning Canal near Corning.
Do	Six 30-in. siphon breakers for Forebay Pumping Plant; and twelve 30-in. siphon breakers for Mile 18 Pumping Plant. Estimated weight: 54,000 lb.
Do	Eight 14.4-kv, station-type switchgear; 15-kv, isolated-phase bus; two 2,000-kva, 13.8-kv to 480-volt, station-service transformers; and 600-volt, non-segregated-phase bus. All for San Luis Reservoir Pumping-Generating Plant. Eight 230-kv, 1,600-amp, 20,000-mva, power circuit breakers for San Luis Switchyard; and one 69-kv, 1,200-amp, 2,500-mva, power circuit breaker for Forebay Switchyard.
Do	Furnishing, installing, and testing six 40,000-hp, 0.95-pf, 13,200-volt vertical-shaft, synchronous motors for the Mile 18 Pumping Plant.
Do	Four 10-mva, 72.5-grd wye/41.9 to 4.16-delta-kv, single-phase, power transformers for the Forebay Pumping Plant Switchyard.
CRSP, Arizona	Four 230-kv, 1,600-amp, 20,000-mva power circuit breakers for Pinnacle Peak Substation, Stage 02.
CRSP, Colorado	Clearing trees, brush, fences, and other structures from about 9,000 acres, and furnishing and installing protective buoy system. About 20 miles west of Gunnison.
Do	Three 115-kv, 1,200-amp, 5,000-mva power circuit breakers for Blue Mesa Switchyard.
Do	One 46,800/62,400/78,000-kva, 3-phase, 115-kv-high, 11-kv-low, OA/FA/FA generator voltage. power transformer for the Blue Mesa Switchyard.
Do	Two 13.5- by 16.07-ft fixed-wheel gates for penstock intakes for the Morrow Point Dam and Powerplant. Estimated weight: 100,000 lb.
Do	Two metal-clad switchgear assemblies; bus structures; two 1,000-kva 12,000/480-volt, station-service transformers; and two 13.8-kv, 1,000-mva circuit breakers all for Blue Mesa Powerplant.
Columbia Basin, Wash	Earthwork and structures for about 20 miles of laterals, wasteways, and drains with bottom widths varying from 16 to 2 ft, of which about 2 miles will be lined with compacted earth lining and about 2.5 miles will be lined with concrete lining. Blocks 21 and 48, near Othello
Emery County, Utah	Constructing the earthfill Huntington North Dam and dikes and appurtenant features. The dam will be about 65 ft high and 2,570 ft long, the East Dike about 20 ft high and 1,100 ft long, and the West Dike about 10 ft high and 1,960 ft long. The combined spillway and outlet works will consist of an approach channel, a concrete intake structure, a 3.5- by 3.5-ft cut-and-cover conduit, a concrete gate structure containing a crest structure for the spillway and gates for the outlet works, and a concrete stilling basin with wave suppressor. At an offstream site about 1 mile northeast of Huntington.
MRBP, Montana	*Schedule No. 1:* Two 14.4-kv, isolated-phase, generator voltage bus structures; two 600-volt, station-service, feeder busways; and three 750-kva, 13.8-kv to 480-volt, 3-phase, station-service transformers. *Schedule No. 2:* Four protective equipment assemblies with appurtenant equipment; four 14.4-kv, segregated-phase, generator voltage bus structures; and four 14.4-kv, station-type, cubicle switch-gear assemblies. All for Yellowtail Powerplant.
MRBP, Wyoming	Constructing about 54 miles of 230-kv, single-circuit transmission line of which about 17 miles will be wood-pole construction with a few steel towers, and 37 miles will be steel-tower construction. The work will consist of clearing right-of-way; constructing access roads; furnishing and installing fence gates; constructing concrete footings; furnishing and erecting steel towers and wood-pole structures; and furnishing and stringing three 1,400 MCM aluminum alloy conductors and two 0.5-in. steel-strand, overhead ground wires. Glenrock-Stegall Transmission Line (Glenrock-Glendo Section) from the Pacific Power and Light Company Substation, near Glenrock, to a point north of Glendo.
Do	Constructing about 3.7 miles of 115-kv, wood-pole transmission line with three 477 MCM, 26/7, ACSR conductors, and two ⅜-in. steel strand overhead ground wires. Constructing about 2.4 miles of 115-kv, wood-pole transmission line with three No. 4/0 AWG, 6/1, ACSR conductors, and two ⅜-in. steel strand overhead ground wires. Furnishing and stringing three 477 MCM, 26/7, ACSR conductors for about 7.8 miles of line; furnishing and stringing two ⅜-in. steel strand overhead ground wires for about 1.4 miles of line; removing three No. 4/0 AWG, 6/1, ACSR conductors from about 6.2 miles of line; removing three 336.4 MCM, ACSR conductors from about 2.9 miles of line; removing two ⅜-in. steel strand overhead ground wires from about 1.1 miles of line; removing structures from about 1.1 miles of line. The work will consist of clearing land; installing gates and fence grounds; furnishing and erecting wood-pole structures; furnishing and stringing conductors and overhea l ground wires; and removing existing conductors and overhead ground wires. Archer Area Taplines, about 5 miles east of Cheyenne.
Do	Additions to the Lovell Substation, Stage 03, will consist of regrading the substation area; constructing concrete foundations; furnishing and erecting steel structures; and furnishing and installing one 115-kv circuit breaker, and associated electrical equipment. Near Lovell.
Navajo Indian Irrigation, New Mexico.	Constructing about 5 miles of concrete-lined tunnel No. 2 of either 17-ft 6-in. diameter horseshoe section or 18-ft-diameter circular section. Near Farmington.
Pacific Northwest-Southwest Intertie, Nevada.	Detailing, fabricating, and testing a Bureau-designed 750-kv, d-c transmission line tower for the Oregon-Nevada border to Hoover Dam Transmission Line.
Do	Designing, detailing, fabricating, and testing a tangent suspension structure for the 750-kv, d-c, Oregon-Nevada border to Hoover Dam Transmission Line.
Silt, Colo	Earthwork and structures for about 7.5 miles of Silt canal with bottom width varying from 6 to 2 ft, of which about 0.5 mile will be lined with compacted earth lining. Near Silt.

*Subject to change.

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What's Coming:

SAFETY IN DAMS
PRODUCING MORE WITH LESS LAND

In its assigned function as the Nation's principal natural resource agency, the Department of the Interior bears a special obligation to assure that our expendable resources are conserved, that renewable resources are managed to produce optimum yields, and that all resources contribute their full measure to the progress, prosperity, and security of America, now and in the future.

Bureau of Reclamation
U.S. DEPARTMENT OF THE INTERIOR

February 1965

RECLAMATION ERA

Commissioner Dominy Finds Spain Also Stepping-Up Water Developments

A Huge Practical Dam Is Shaping Up Across a Normally Dry Creek Bed

An Expert Speaks on Safety in Dams and Defeating the Worst in Water

Reclamation ERA

FEBRUARY 1965

Volume 51, No. 1

OTTIS PETERSON, Assistant to the Commissioner—Information
GORDON J. FORSYTH, Editor

THE SIZZLING FIREWORKS PHOTO on the cover was a prize-winner in a recent exhibit by the American Society for Testing and Materials. It shows a test like the action of a real lightning bolt—one of the many possible tests of the Bureau's new mobile laboratory now in use. Soon after the lab first arrived, it was described in the May 1964 issue of the *Era*.

United States Department of the Interior
Stewart L. Udall, Secretary

Bureau of Reclamation, Floyd E. Dominy, Commissioner

Washington Office: United States Department of the Interior, Bureau of Reclamation, Washington, D.C., 20240.

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Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C., 20240. Use of funds for printing this publication has been approved by the Director of the Bureau of the Budget, January 31, 1961.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Price 15 cents (single copy). Subscription price: Eight issues (2 years) for $1.00 ($1.50 for foreign mailing).

SPAIN

Increases Dam Building

by Reclamation Commissioner
FLOYD E. DOMINY

THE construction of large dams in Spain has greatly accelerated over the past 30 years. Although two dams built by the Romans are still in operation and four others were completed before the beginning of the 18th century, the total number of dams completed and in operation in Spain in 1934 was only 97. Since that time 247 dams have been completed—a tremendous tribute to the vision, ingenuity, and skills of our Spanish contemporaries.

The greatest motivation for such increased activity in dam construction has been the increasing critical need for electrical energy for industrial growth. Because Spain is not rich in deposits of fossil fuels, hydropower is of special importance to the national economy. As a result, 70 percent of the electricity now generated in Spain is of hydro origin, and more hydro projects are under construction or being planned.

Prior to 1934, water supplies were developed primarily for irrigation and domestic purposes. consequently, storage and regulating reservoirs on the arid Mediterranean watershed outnumbered those on the Atlantic watershed where year-round water supplies are more abundant.

Recent industrial advancement and the resulting ascending economic and social standards have greatly affected the Spanish concept of water resources development. At present, while not ignoring the necessary further development of available water supplies in the Mediterranean watershed, more emphasis is being placed upon the utilization of the large quantities of water that flow into the Atlantic Ocean for producing electrical energy. This is well demonstrated by the following chart on the location of that country's dams;

	Dams constructed in watershed		*Total Spanish dams*
	Mediterranean	*Atlantic*	
December 1934	58	39	97
1934 to 1964	82	165	247
Total, Apr. 30, 1964	140	204	344

Torrential flows over the ages have cut deep, narrow gorges into even the hardest of rock. In this way Nature has provided sites which, when properly developed by man, result in benefits far in excess of the cost of development. Such physical characteristics of much of the Atlantic watershed are conducive to construction of high dams, which are the economical producers of electrical energy.

The topography and geology of hydropower damsites have favored construction of concrete dams and, in many instances, underground powerplants. One-fourth of the total completed powerplant capacity is installed underground.

Spanish engineers, intent on deriving optimum benefits from available water resources, have achieved excellence in all technological aspects of design and construction of dams and hydropower installations. From preliminary studies and investigations through all phases of design and construction, the latest engineering techniques have been scrutinized, applied where suitable, and extended as necessary to solve specific problems. Competent specialists in the fields of hydrology, hydraulics, rock mechanics, stress analysis, mechanical and electrical equipment, concrete technology, construction techniques, and operation and maintenance have been developed. Supporting facilities such as field testing equipment, hydraulic and structural laboratories, and electronic computer installations are widely utilized.

Spain's double curvature, thin, concrete-arch Eume Dam has an overflow spillway.

Last September I made an inspection tour of dams, hydroelectric powerplants, and irrigation in Spain under the auspices of the Spanish National Committee of the International Commission on Large Dams. Accompanying me were two design engineers on my staff, Harold G. Arthur and Alfred T. Lewis, also my son Lt. Charles E. Dominy who is an engineer with the U.S. Corps of Engineers stationed in Germany.

It was discernible throughout the country that rapid technological advances had been made by Spanish engineers. Two examples of that country's modern hydropower technology are the recently completed Aldeadavila Dam and Belesar Dam and their powerplants.

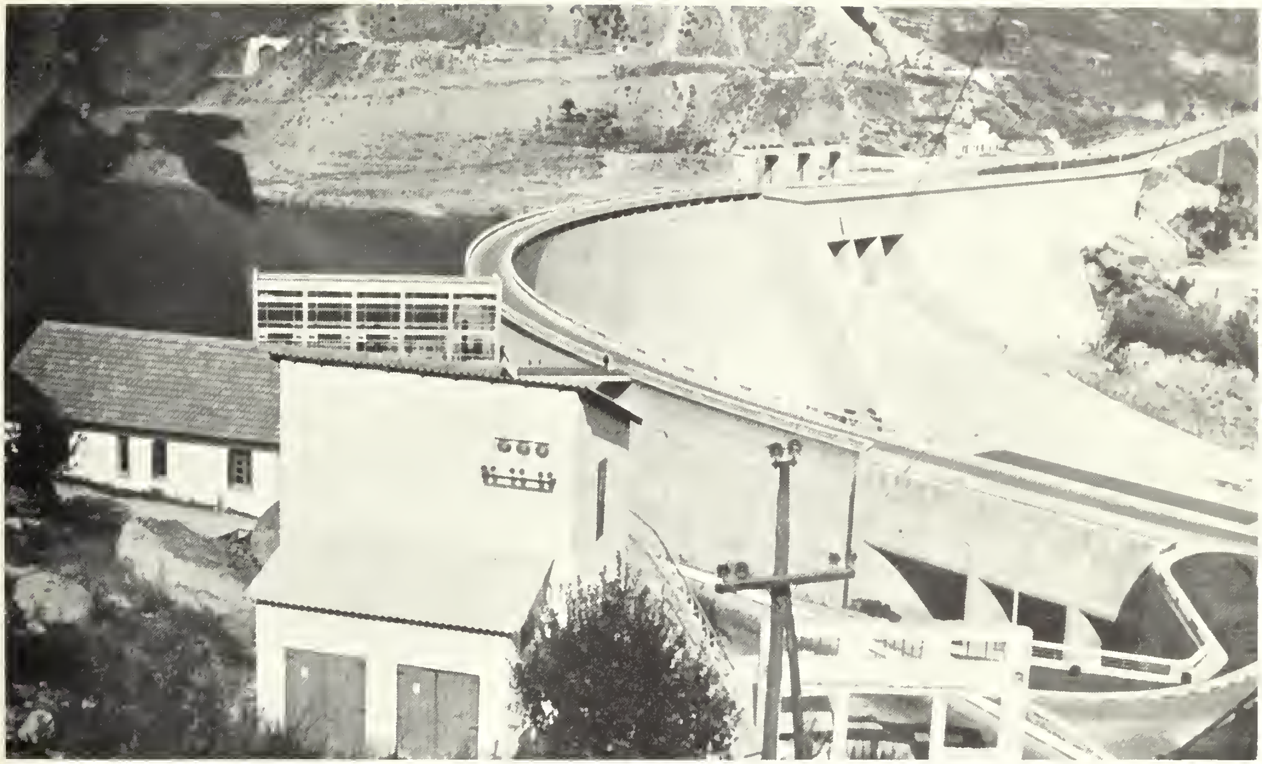
Aldeadavila Dam

This dam, one of the major structures in Spain, is located on the reach of the Duero River which forms the international boundary between Spain and Portugal. The project completed the development of the international stretch allocated to Spain by the Spanish-Portuguese treaty of 1927.

The dam is an imposing concrete arch structure 453 feet high with a crest length of 820 feet. An overflow spillway with a maximum capacity of 413,000 cubic feet per second is located in the central portion of the dam. Flows are controlled by eight gates on the crest, contained on the downstream face by four converging chutes, and discharged into the river slightly above channel level by a ski-jump apron. To supplement the overflow spillway, a tunnel controlled by automatic gates is located in the right abutment. The total spillway capacity is one-half of that of the Bureau of Reclamation's famed Grand Coulee Dam on the Columbia River.

The underground Aldeadavila powerplant with an installed capacity of 718,000 kilowatts is the largest in Western Europe and is more than one-half the size of the Hoover Dam Powerplant on the Colorado River. Six 16.4-feet-diameter penstock tunnels supply six 170,000-h.p. Francis turbines operating under a maximum head of 456 feet. Two tailrace tunnels—each provided with a 174-feet-high surge tank—return the water to the Duero River.

Housing the turbines and generators is a machine hall excavated in hard, massive granite. The excavation was 456 feet long, 59 feet wide, and 133 feet deep. The walls and roof of the hall are not



The graceful lines of Belesar Dam show one of its ski-jump spillways in right-center of the picture.

lined nor supported by concrete, but pleasing architectural effects are achieved by ceiling panels, reinforced-concrete trusses which support crane girders, and effective interior lighting. The transformer vault is also an excavated chamber bringing the total volume of underground excavation at the Aldeadavila installation to 785,000 cubic yards.

Belesar Dam

Located on the Mino River in extreme northwestern Spain, Belesar Dam and powerplant is an important hydropower installation which feeds the aluminum plant, oil refinery, and other industries located at the seacoast city of La Coruna.

It is a mammoth and impressive dam with ski-jump spillways. The main portion has a double curvature arch 423 feet high and 788 feet long.

Belesar Dam displays not only the graceful lines of a thin arch but also the massive look associated with gravity sections. This combination of structure types was necessary because of the geologic and topographic characteristics of the site. It is a relatively wide valley with geological weaknesses in the upper reaches of the canyon walls, particularly on the left abutment. Full utilization of the available water supply and power head, however, dictated the dam's height. Narrowing the canyon walls artificially by the gravity sections served dual purposes; it provided the space to incorporate the spillways and allowed construction of an economical thin-arch dam.

(*Continued on page 17*)

The American study team which visited Reclamation works in Spain are from left, Lt. C. E. Dominy, Harold G. Arthur, Commissioner Dominy, and Alfred T. Lewis.

BUILDING A RECLAMATION GIANT in CALIFORNIA

THE Bureau of Reclamation is building one of the largest dams in the world across one of the smallest creeks in California.

When completed in 1967, San Luis Dam will stand 320 feet high and stretch 3½ miles across the normally dry bed of San Luis Creek.

But the water to fill San Luis Reservoir won't come from tiny San Luis Creek. As a matter of fact, the runoff from the creek won't match even the annual evaporation from the more than 2 million acre-feet of water that will eventually be stored behind the dam.

These anomalies provide a unique background for San Luis Dam, but the practical structure and its related works will have a high payoff from multiple-use operations.

San Luis Dam is part of the half-billion-dollar San Luis Unit of the Bureau of Reclamation's Central Valley Project.

The San Luis Unit is being constructed by the Bureau of Reclamation. Since its major features are to be used jointly with the State of California, the State is paying a proportionate share of the costs. This is the first such Federal-State project in the history of the Bureau.

By connecting the facilities of the Federal Central Valley Project with the California Water Project, the San Luis Unit will make it possible for water originating in the watersheds of the Trinity and Sacramento Rivers to be used as far south as San Diego. This is the geographical equivalent of taking water-from New York's Hudson River for use in Charleston, S.C.

Key features of the unit are rapidly assuming recognizable shape on the west side of the San Joaquin Valley, 12 miles west of Los Banos and 100 miles from the unit's water supply in the Sacramento-San Joaquin River Delta.

Huge machines, some of them especially designed for the challege of moving the 75 million cubic yards of material that will be packed into the dam, are digging, hauling, and compressing thousands of tons of earth 24 hours a day.

Towering above the valley floor, like a ferris wheel in a parking lot, is the giant excavator built to dig and load more than 100 tons of earth a minute.

Instead of seats, this "ferris wheel" has 10 bucket shovels which scoop more than 2½ tons of earth at a bite from an embankment of earth. As the wheel turns, the buckets empty onto a conveyor belt.

At the other end of the belt are two loading chutes. As the gate on one of the chutes bangs closed, one truck pulls forward with its 100-ton load and makes a 30-mile-per-hour run to the damsite. At the same time, the other chute opens, sending earth cascading down into a second truck already in place. At blaring horn signals from the excavator operator, the second truck moves ahead in quick starts and stops so that the load may be evenly distributed—and still another truck pulls into place beneath the closed chute.

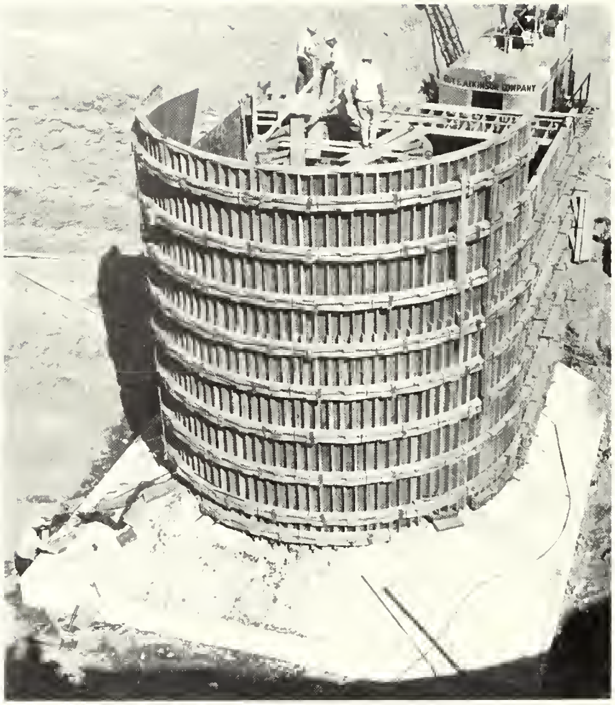
Munching Embankments

Every 45 seconds a truck is loaded and moves out. The wheel excavator slowly moves forward munching its way through the embankment as though it were a chocolate bar.

At the damsite, the bottoms of the truck beds drop open, spilling the earth material on the dam. Bulldozers crawl in to spread it, followed by sheepsfoot rollers—heavy drums with hundreds of tiny cylindrical "feet"—which roll over and over and over it, tamping it into sure compactness. This places the "zone 1" and "zone 2" material for the dam—the material that is most nearly impervious to water and makes up the core of earthfill dams.

The heavier material used to anchor the dam in place and protect it from the elements is being blasted from the earth in the hills overlooking th

Workers' cars parked in lower left are in the bottom of the pump generator plant area just below the main San Luis Dam. In a few months the dam will be built up as high as the top of the mornin glory spillway tower at right.



Building a huge form for the spillway inlet of the Forebay Pumping Plant.

damsite. There an electric shovel with a 15-cubic-yard bucket goes through a monotonous day-long ritual—scoop, lift, swing and dump; scoop, lift, swing and dump; scoop, lift, swing and dump.

After each three cycles, a loaded truck leaves carrying 65 tons of rock and an empty truck comes to rest beneath the shovel. Loaded trucks hurry a few hundred yards down the hill and dump their loads at a rock separation plant.

Smaller rocks, those less than 8 inches in diameter, plunge through a screen of thick steel bars—the grizzly—onto a conveyor belt and down 3,500 feet to the bottom of the hill. Other trucks drive through a tunnel beneath the cone of rocks spilling from the conveyor, are loaded, and speedily moved to the damsite.

The larger rocks bounce off the grizzly and roar their way through a series of baffles that guide them into the reinforced beds of still more trucks waiting below. Steel chains, resembling the tracks used on combat tanks, flap like sheets in the wind as they prevent the bouncing boulders from flying out of the separation chutes.

These larger chunks of rocks, known as riprap, are placed on the outside of the dam on the upstream face. A 24-inch blanket of rocks less than 8 inches in diameter goes on the downstream face.

At the north end of the downstream face of the dam, construction is well along on the pumping-generating plant through which the water will pass into and out of the reservoir by means of pump turbines.

Tunnels have been bored through the natural rock that will serve as the core of the dam at this point. Sections of steel pipe are neatly stacked, waiting for a specially designed rig which will roll through them, then lift and carry them into place in the tunnels. Concrete will be poured between the pipes and the walls of the tunnels to hold them in place.

A mixture of water and cement making a mortar called grout has been forced through drilled holes into the natural nooks and crannies of the rock bed under the dam and around the tunnels to solidify it and prevent any leakage.

Pump-Turbine Operation

Giant combination pump turbines will be placed in the pumping-generating plant when it is completed. These eight pump turbines will be one of the structure's most interesting features. The plant will pump the water brought to the forebay of the dam by the Bureau of Reclamation's Delta-Mendota Canal and the State's California Aqueduct into the San Luis Reservoir for storage. The pumps will have a capacity of 500,000 horsepower, more than three times that of the Bureau's huge pumping plant at Tracy.

When the water is needed for use by the Bureau along the San Luis Canal or by the State on the southern coast of California, it will be released through the pump turbines which will turn the generators in the plant. The generators will be able to produce up to 424,000 kilowatts, greater than the capacity of the Bureau's Shasta Dam powerplant.

From the forebay, the water will flow into the San Luis Canal, which also is under construction. The largest piece of equipment working on the canal is a walking dragline. It throws out a 15-cubic-yard bucket from its 165-foot boom, reels it back and lifts and dumps it over the side of the canal. A fleet of self-loading scrapers with powerful electric motors on each of their eight wheels helps remove the earth from the canal.

Working behind the dragline and the scrapers is a giant trimmer, which shapes the sides of the canal to the correct angle. Next comes the liner with its movable form for use in placing the canal's concrete lining.

At Mile 18 Pumping Plant, also under construction, the water will be lifted to flow by gravity through the final four reaches of the canal.

The San Luis Canal will be one of the major waterways in the West, with a width in the first reach of 257 feet and a depth of more than 36 feet. It will run 103 miles south through the Bureau's San Luis service area to Kettleman City. From that point, more than half of the water carried through the canal will enter the southern section of the State's California Aqueduct. This water will be lifted over the Tehachapi Mountains and used for irrigation, municipal and industrial supplies in the southern coastal region.

About 25 miles above Kettleman City, a pumping plant will lift a portion of the water 138 feet into the Bureau's Pleasant Valley Canal, which will carry in to a Federal service area.

Preliminary excavation of the dam's two foundation trenches uncovered archeologically important remains of pre-Columbian Indians and such prehistoric animals as the mammoth. Helped by Bureau of Reclamation employees, State archeologists and students from the University of California at Los Angeles removed relics from Indian burial grounds 1,500 years old.

Most of the facilities in the unit on which construction first started in early 1963 will be completed by 1967. The estimated total cost of construction is $481 million. Cost of the joint facilities is estimated at more than $354 million. Fifty-five percent of the joint costs will be paid by the State of California.

Construction of the joint facilities for mutual use will save the Federal Government and the State of California $30 million each in construction costs alone. This mutually advantageous financial accomplishment stands as a record-breaking example of Federal-State cooperation. Many more millions of dollars will be saved for both agencies in operations and maintenance expenses over the years.

When completed, the San Luis Unit will serve more than half a million irrigable acres. The addition of a firm supply of irrigation water to these rich lands will result in a diversification of crops which will tremenduously increase the economic benefits both to the local community and the Nation at large. # # #

Man in low center is pulling on the trip-ring to release another bucket of concrete at Mile 18 Pumping Plant.

No Halfway Measure for—

SAFETY IN DAMS

by B. P. BELLPORT, Chief Engineer

MAN'S struggle to control and store water dates back to the dawn of history. He has built dams of nearly every size and description, in nearly every corner of the globe. Ancient cultures have disappeared leaving behind remains of such structures, some of them nearly 60 feet high—an impressive height in the light of the crude construction methods of that early time.

Unfortunately, history also tells us that many of these dams did not perform as planned. Dam failures when mentioned by engineers include those which may have failed partially or completely, some of which required unanticipated remedial work. Statistics show at least 1,800 such incidents dating back to the 12th century.

The loss of life and suffering from some disasters have been strangers to no part of the world or time in history. Prominent dam failures in this country include Mill River Dam in Massachusetts in 1874, drowning 140; the Johnstown Flood in Pennsylvania in 1889, causing a loss of life totaling 2,200; St. Francis Dam in California, killing 426 in 1928; and the Baldwin Hills Dam in California last December, killing 5 persons.

This long and dramatic history of devastation as related to controlling and storing water has served to shock the public into an awareness of the need for safety—an awareness and need we have long felt in the Bureau of Reclamation.

The Bureau is now in its 64th year of bringing out the best and defeating the worst in water. During these many years, the Bureau has built 176 storage dams with a capacity of more than 120 million acre-feet.

Providing safe storage of huge bodies of water is a great responsibility. As a result, each of its structures has been invested with the greatest engineering skills and experience in investigation, planning, testing, research, design, construction, and maintenance to provide the maximum durable safety for dams, people, and property. The structures must perform reliably, not for years or decades, but for centuries.

Building a dam today involves the work of varied technical specialists. The combined capabilities and talents of the engineer, hydrologist, chemist, physicist, petrographer, geologist, and scientist are needed to work in concert with the designer. Skilled in electronics, automatic data processing, and scores of other tools of their specialties, they evaluate, test, and solve the problems of design and construction.

The smallest details can sometimes make the biggest differences in quality and durability of construction. For example, the concrete-making materials—cement, rock, and sand—are minutely analyzed by X-ray, whereby even the atomic structure of crystals is identified and measured.

The Safe Foundation

No dam is more sound than the foundation on which it is built. One tabulation indicates that 40 percent of all dam failures have been caused by inadequate foundations. The foundation must have adequate strength even when wet and under the load of the dam and water in the reservoir.

If, for example, the foundation is a clay material, its strength can be measured by a specially developed vane shear test apparatus. This bladed device is inserted in the foundation material and the torque required to turn the blades gives a measurement of the soil strength.

Should the foundation be of rock, the engineer wants a clear picture of the types of rock that lie beneath the surface to a depth of possibly several hundred feet. Traditionally, he calls for the drilling of rock cores. Now, he can call for a new aid to take his critical eye to the parent rock as it lies in place. The Bureau uses a recently developed compact television camera which is lowered in the small-diameter drill holes for direct visual examination of the foundation rock deep beneath

Large radial gates, which control the flow of water over the spillway of a dam, are periodically inspected.

Concrete is freshly poured, strainmeters and their cables are placed by hand—this is early in the construction of Glen Canyon Dam.

the surface. This is the only such television camera in the United States. With this device he can "see" the cracks and seams that must be sealed by grouting. He can locate and measure such characteristics as the "strike and dip" of the beds of rock and he can detect the presence of "geologic faults."

A variety of drilling and sampling methods, exploration tunnels, and geophysical techniques are also used. The Bureau is now able to determine in the field the elastic properties of foundation rock with load bearing or "jacking" tests. These tests are conducted in exploration tunnels in the foundation area where the jacks apply pressure of up to 800 pounds per square inch. The application and relief of these pressures allow the measurement of the rock's elasticity, permitting a more accurate prediction of rock behavior under load.

Geology Is Considered

Not only the local geology but regional geology also must be considered when constructing a dam and storing a large amount of water. Hoover Dam and Lake Mead, its reservoir, can be pre-

These two men show how an inspection reading is made on strainmeters that have been embedded in concrete.

756-096 O—65——2

Geologist Malcolm Logan is shown viewing the screen of the TV borehole telescope which is in the ground approximately 70 feet.

sented as an example of the demands placed on the foundation. When Lake Mead is at maximum storage it contains 31,047,000 acre-feet—more than enough water to cover the entire State of New York 1 foot deep. This water in storage weighs a total of 42.2 billion tons, while the maximum water pressure at the base of the dam is 45,000 pounds per square foot. Settlement from this imposed weight was anticipated and caused a sinking of the earth's crust in the general area of approximately 7 inches.

Because each reservoir may have to cope with a major flood, it is important for the hydrologist to establish the maximum probable flood that must be carried safely out of the reservoir and past the dam. The characteristics of such flows are determined to properly design dams, spillways, and outlet works by thorough studies of streamflow, precipitation, watershed runoff experiences, as well as a forecast of major storms.

The designers lay out the plans and arrangement of the dam and related works, determine all the forces acting on the structure, and proportion them to achieve the greatest safety, economy, and efficiency. The Bureau places emphasis on the detailed technical specifications and the drawings which "spell out" each aspect of the work. The specifications and drawings for the San Luis Dam and related works in the Central Valley of California filled 3 volumes and totaled 337 pages of text and 409 detailed drawings.

Improvements in the design, as well as new techniques and materials for use in construction, upkeep, or repair are aided through the Bureau's research laboratories in Denver. Materials receive tests for strength, durability, conformity to specifications, and methods of use. Test data are obtained on rock, soil, cement, concrete, wood, metal, asphalt, rubber, plastics, paints, and many other materials.

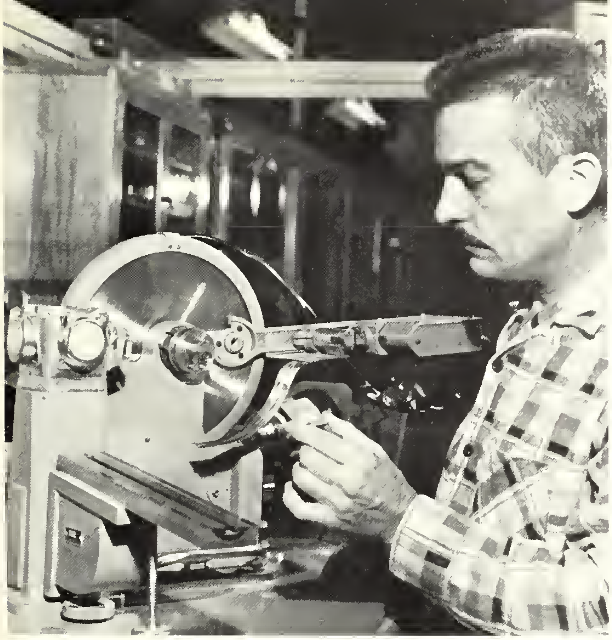
Scale models of certain structures to be constructed or machinery to be used are built and tested with water to verify and evaluate preliminary designs and solve unique problems.

When construction actually starts on the dam, all stages of the work are visually examined, measured, or tested by Bureau inspectors. This inspection program assures that all requirements of the plans and specifications are being met by the contractor.

Delicate and exact instruments are placed in concrete dams to provide detailed information on the behavior of the structure under working loads of water. They indicate how the dam responds to a wide variety of influences of loading and unloading by measuring stress, strain, volume change, joint movements, deflections, temperature change, and pore pressure. For example, a total of 1,100 such instruments have been placed in Flaming Gorge Dam recently completed in northern Utah. Information on the condition of this 502-foot concrete arch structure has been available beginning with the placement of concrete and continues as the reservoir fills. For earth dams, samples of the different soils are evaluated for their engineering behavior as actual construction materials. The material must demonstrate that it will "stay put" and perform according to design.

Performance Data

When earth dams are of unusual size or involve particular problems, embedded instruments are employed to provide data on performance during and after construction. For example, San Luis Dam in California, currently under construction, is a zoned earthfill dam 18,500 feet long with a volume of 78 million cubic yards. It will be the world's third largest dam of its type. Instruments within the dam will measure foundation settlement, embankment consolidation, and water pressures within the embankment.



A powdered rock sample is being placed on an X-ray instrument so that specialists can obtain a mineralogical analysis of the sample.

All instrument readings are taken at specified intervals and sent to the engineering headquarters in Denver for evaluation and study. The data obtained from instrumentation and from construction control tests are compared with design assumptions, making possible improved design practices for future construction.

Responsibility for the safety of a dam continues after it is completed and placed in operation. The Bureau's experienced engineers periodically examine the structures as a part of a continuing program of inspection during operation and maintenance. Under the Bureau's Review of Maintenance program, field personnel and representatives of the Chief Engineer examine principal structures and facilities on a regular schedule. This program encourages effective maintenance and provides the opportunities to evaluate the performance of the equipment and structure and suggest improvements.

The safety of the structure is further assured by the operating criteria which are issued for each dam. An operator's handbook of printed instructions is provided for all equipment. Special attention is directed to observation of the dam's condition during periods of changing water levels. Remedial measures are taken on evidence in the dam of abnormalities such as any cracks, slides, sloughs, subsidences, impairment of slope protection, springs, seeps, and boggy areas caused by seepage.

Safety is a continuing activity and future generations must be able to rely on it. It starts with preliminary planning and has no end.

Today, the accumulation of man's knowledge and skills to accomplish safety and reliability in structures is applied. Constantly, new advances are increasing the capabilities and every tool and technique are utilized to provide safety for dams, people, and property. # # #

Pointing to the probe of the TV boreholed telescope as it is entering a 3-inch borehole is, Roxy Root, geologist.

On the Canadian River Project, Texas . . .

SO THAT HISTORY MAY NOT REPEAT

by IDA MAE ELLIS, Amarillo, Texas

Accolades for achievements have been accorded 20th-century builders. In the advanced field of construction are the large dams in the western United States which have been built by the Bureau of Reclamation.

One of these accomplishments is Sanford Dam, now under construction about 40 miles northeast of Amarillo, Tex. It is the principal structure in the $96 million Canadian River Project, which will impound municipal water for delivery through a 322-mile aqueduct system to 11 participating project cities in the Texas Panhandle. These cities are Amarillo, Lubbock, Pampa, Borger, Plainview, O'Donnell, Brownfield, Levelland, Tahoka, Slaton, and Lamesa. Thus, modern man continues to strive for survival and perpetuity through a more dependable and improved water supply.

An interesting flashback in time, however, reveals that contiguous to the Sanford Reservoir—locally referred to as Lake Meredith—one can be whisked back thousands of years, and see actual remains of prehistoric man's habitat. Eminent anthropologists, archeologists, geologists, and historians have ascertained that some 12,000 years ago, various bands of Ice Age hunters, pre-Indian warriors, traveled the valley of the Canadian River. In about A.D. 900 the first group of prehistoric Stone Age farmers moved into the Canadian River Valley, built pueblos with accessory structures of stone and adobe, the remains of which are still evident within the environs of the reservoir site.

Villages containing 100 rooms were built in series. Remaining evidences of culture in the ruins appear to be a northern plains type, but the architecture seems to be of Puebloan or southwestern origin.

On the perimeter of the Sanford Reservoir is found the Alibates Ruins complex—possibly of joint ancient American-Indian ownership. Many of the rooms were excavated in 1930 by a Works Progress Administration crew, but other rooms are yet to be explored. The walls were constructed 3 or 4 feet high of double rows of stones, the space in between being filled with rubble and adobe. On top of these were horizontal layers of rock with adobe binding, usually to a height of about 6 feet. Cross-beams supported by the outside walls and four upright posts on the inside of the dwelling formed the ceiling. An opening on the roof was the entrance, and another was a smoke vent. The interior was plastered with thin even coatings of adobe.

Several thousand identifiable artifacts have been removed from the ruins, many of them not native to this region.

Though the people were sedentary, extensive and permanent habitations, artifacts, and animal remains indicate that their economy was concerned with maize agriculture and the hunting of bison, antelope, and deer.

The hunters made extensive use of the beautiful rainbow-colored, Alibates flint, weapon paints—indigenous to the area, as reflected by the quarries in this vicinity. Geologists have noted that the browns in the flint were chosen in the first mining, then the blue and white. But red colors predominated for trading purposes. Alibates flint was evidently among the best on the continent, for from this material the Indian settlers fashioned their hide scrapers, double-bladed knives, hammers, awls, weapon points, and other such tools. Home areas are littered with flint chips and chipped artifacts, some places several feet in depth.

The Alibates Flint Quarry consists of numerous pits along the south rim of a flat-topped ridge, capped and supported by the flint bed, that lies along the south shore of the future Sanford Reservoir. Many depressions, now almost filled with topsoil, represent prehistoric quarry sites. These flint quarries were valuable not only because they provided a source of material for home tools but also because the flint "blanks" (ready-to-work chunks) were the medium of exchange and barter. Samples have been found in several areas of the North American Continent.

A model of an ancient Indian village which contained about 100 rooms.

Tools were manufactured from the blanks and traded to other migrating tribes. It has been said that the Alibates Quarries and workshop area is the earliest and longest lived industry developed on the North American Continent.

Forced to Migrate

When these early inhabitants lived along the Canadian River, climatic conditions were favorable, but as arid conditions developed, the lack of rain forced them to migrate elsewhere. Many famous aboriginal, nomadic Indian tribes roamed and fought in this vicinity during the first half of the 19th century, and had dealings with such well-known characters as Kit Carson, the Indian scout, and General Custer, of the U.S. Army. However, the exodus of the Indians at about the middle of the 19th century motivated white settlement. A few Anglo-Americans established residence here in 1874, and Panhandle cattle ranching began. Until railroads were constructed and farming started, the first settlements were trading posts.

In further growth, the land was converted from cattle ranching to growing crops, the production and processing of oil and natural gas, and the introduction of irrigation wells.

Present-day citizens are aware that "without water the people perish," and that there can be no substained economic development without an adequate water supply. To obtain a guarantee of water was a prime factor in prompting the construction of the Canadian River Project. It provided the impetus for the Texas Panhandle cities to make investments, both for the present and for posterity. In addition to water conservation, the Sanford Reservoir will provide the entire area with recreation facilities, including all water sports, fishing, hunting, camping, boating, and picknicking units. Panhandle enthusiasts are clamoring for just such recreation on these broad High Plains, and tourists will have an additional vacation spot.

Sanford Dam is scheduled for completion in the summer of 1965. But even now, visitors to the area are sightseeing and visualizing the dam, the reservoir with its thousands of acre-feet of water, and their "Dream-Come-True" project. Also for the rock collector, the photographers and the tourists interested in history and Indian lore will be the ancient dwellings and ruins of those who explored, fought, lived, died, and were forced to depart from the Canadian River shores. In the distance, on lands nearby, one may see a deer or antelope at play, or even a buffalo roam—perhaps reminding him of the symbol of the Department of the Interior—the agency which helped bring about the benefits of this water resource development.

# # #

(Historical data were furnished by Mr. Henry E. Hertner, vice chairman, Potter County Historical Survey Committee, Amarillo.)

DREDGING THE BRAIDED COLORADO

by PAUL A. OLIVER, Regional River Control Engineer, Boulder City, Nev.

In a work program expected to extend over 4 to 5 years, a 16-mile stretch of the interlacing and meandering channels of the lower Colorado River in Cibola Valley will be rechanneled into a canal-like section which promises to repay work costs in salvaged water.

The Colorado, a 20-inch, hydraulic, cutter-head dredge is named after the river. It sits on the waters of the braided Colorado River and tirelessly churns and pumps—dredging up silt and sand to salvage water. This patient creature, and two smaller ones of almost the same design, can be found at work on the California-Arizona border part of the river for the next several years. The work they do will salvage a lot of water which can be put to practical use in water-short areas.

Credit goes to *The Colorado* for rechanneling 30 miles of the Colorado River completed 4 years ago near Needles, Calif. By that correction work, water tables were lowered and drainage improved, resulting in 60,000 acre-feet of water salvaged per year.

Work started this year in the Cibola Valley south of Blythe will save approximately 36,000 acre-feet a year. In fact, the total river improvement program, conservatively estimated, is expected to recover annually some 190,000 acre-feet of water now being lost to evaporation and transpiration from the 240 miles of river between Davis Dam and the border of Mexico. It will also reduce erosion and sediment which have been detrimental to downstream irrigation facilities.

The probability of summer floods up to the maximum level is always considered in the designing of water developments.

Although construction of upstream dams on the lower Colorado has reduced floods to some extent, a floodflow of 80,000 cubic feet per second could be expected from the drainage basin below Parker Dam and above the Cibola Valley project area. Seven major tributary washes having a total drainage area of 5,200 square miles terminate in this river reach.

As a result of the construction of levees along each side, the channel will contain the floodflows which probably will occur seasonally.

In order to protect the fish and wildlife habitat of Cibola Valley from possible damaging effects of the project, several improvements and modifications in the designs recommended by the Bureau of Sport Fisheries and Wildlife were included in the planning report. Additions to the program will include facilities for regulation of impounded water levels in bypassed reaches of the river, building boat ramps, construction of inlet works for freshening flows to bypassed areas and realinement of levees. State fish and game agencies will be on hand to assure maximum enhancement of wildlife habitat in the channelization program.

New Channel Banks

While the program will involve dredging in excess of 10 million cubic yards of material, other work will assure permanence of the channel. It is estimated that a total of 250,000 cubic yards of riprap stone will be placed along the new channel banks to resist river erosion. Over 50 miles of road will be constructed or regraded for access from quarries and gravel pits. Two timber bridges will be constructed over the river to provide access for operations and to relieve severance problems resulting from a major shift in the channel.

Because of the scope of the improvement work along the 240 miles of river, two additional dredges in the 12-inch size have been acquired, and a fourth dredge—which is expected to be a 16-inch machine—is programed for acquisition. The size of a hydraulic dredge is determined by the diameter of its discharge pipeline. The Bureau operates the two 12-inch machines at widely separate points on the river in operations which intercept the sediment load carried by the Colorado River.

One of the 12-inch dredges, *Little Colorado*, is stationed on the new channel near Needles. Until fiscal year 1966, it has a job to do there in a settling

basin. This basin is an overwide section of dredged channel that collects the finer material which the river is sorting out from bottom material upstream. As the Topock Swamp Area adjacent to the settling basin provides ample disposal area, it is possible for the dredge to intercept the transported material and deposit it in the swamp before it reaches the headwaters of Lake Havasu. To allow continued deposition in the upper lake area, would not only cause aggradation in the lower reach of the dredged channel, but also would aggravate the already severe disposal problem facing the Bureau in its planned dredging in Topock Gorge.

60,000 More

The Topock Gorge dredging operation using *Little Colorado* will help drain a large part of Topock Swamp and recover annually thereby approximately 60,000 acre-feet of water—almost two-thirds of the amount now being lost through evaporation and transpiration.

The other 12-inch machine, the *Gila*, is presently excavating in a swamp area downstream, between Imperial Dam and Laguna Dam. Though the dredging of settling basin and channels here is done to solve the same problem prevailing upstream, the existing and planned upriver improvements are tackling the problem at its source by the reduction of bank erosion and sediment transport.

Not all channel control work on the southern part of the Colorado River is accomplished through dredging. There are stretches where the natural channel is well entrenched and in reasonably good alinement, the bed material being of a size to provide a natural armor. In some reaches, control effort is directed toward consolidation of split channels into a single channel, correction of misalinements and reduction of bank erosion. These objectives are accomplished by construction of jetties, training dikes of gravel faced with riprap, or by placing gravel and riprap stabilizing material along the natural banks.

For the past 3 years a river bankline stabilization program has been in progress in the 28-mile southerly reach below Palo Verde Dam. Farther north, a similar program is proposed for the 16-mile reach of river below Parker, Ariz.

Fish and wildlife agency review of the proposed study program for the river reach between Parker and Palo Verde Dam have been completed. In order to obtain maximum benefits in the total development effort, results of the studies will be incorporated with the Bureau's channel improvement plans directed toward salvaging several additional thousands of acre-feet of Colorado River water. # # #

At this stage of channel construction by "The Colorado" dredge, the operator walks to his work over a pontoon pathway.

WEED EMPHASIS DAY *in Minidoka*

by TERRANCE A. GULLEY

(Mr. Gulley is Manager of the North Side Irrigation Field Division, Minidoka Project, Rupert, Idaho.)

Why should we emphasize weeds? Or set aside a special day to recognize the pests?

Weeds annually rob American farmers of millions of dollars and steal more than 1.5 million acre-feet of precious water. The emphasis is given, not because of any great love for weeds, but for the purpose of drawing to the attention of farmers and business and professional people, the losses and expense caused by the pests and their threat to the future of agriculture.

Through increased familiarity with the problem, we are hoping for more community enthusiasm and effort in combating the pests. First established in 1960 as a *Weed Indentification Day* for employees of the North Side Pumping Division, its success generated enthusiasm leading to the annual *Weed Emphasis Day* for all of Minidoka County.

Under the leadership of the Minidoka County agriculture agent, *Weed Emphasis Day* is carried out by a committee of local leaders representing farmers, businessmen, irrigation districts, county weed districts, the State extension service, and the Bureau of Reclamation. Its purpose is not only to encourage greater understanding of weed problems, but to adopt improved practices which will save farms and ranges from weed infestations.

Beginning at 9:45 a.m., a caravan of cars, carrying 100 or more enthusiastic men and boys, leaves the county courthouse at Rupert, and visits selected areas where improved practices in the use of herbicides, equipment, and methods are being demonstrated.

Actually comparing the use of herbicides and methods in farm fields and on canal and lateral banks is more convincing than all the words at man's command.

And believing in the adage, "Man's interest and enthusiasm wanes without rest," ice-cold pop is served during short rest periods by local weedicide dealers.

Completing the tour of field demonstrations, the eager weed eradicators converge on Rupert where a bounteous luncheon of fried chicken, salads, pie, and ice cream, is served by the A. & B. and Minidoka Irrigation Districts.

Anxious to learn more about the important task of weed control, all participants enter into a friendly informal contest in the identification of the most troublesome weeds. Potted or balled weed specimens in their natural state, numbered and assembled on tables, set the stage for comparisons and interesting discussions of the characteristics of each species and the herbicides and methods most effective in their eradication and control.

Climaxing the program is a meeting at which the group is treated to a summary of the latest information available from research, field demonstrations, and successful farmers. Talks are given by farmers who successfully control weeds, and by recognized specialists. Thus *Weed Emphasis Day* ends with a feeling that progress is being made in this important phase of our agricultural program.

Adjournment is at 3 p.m. to allow the farmers time to go home, change their irrigation water, do the chores, and think about weeds—we hope.

Through such meetings and tours, our farmers and those who operate our water distribution systems are prepared and encouraged to cooperate to whip this big problem.

Weed Emphasis Day is already reaping results. Some of the farmers show more interest in the problem and are demonstrating recommended control measures on their farms. Interest is growing annually. Eventually it is hoped that all landowners will participate in this serious battle against noxious and poisonous weeds.

Noxious weeds have long been a problem in the county. Knowing this, the Minidoka Irrigation District, which has operated for some 57 years, has been actively dealing with it for a long time.

The problem became even more apparent in the county when the North Side Pumping Division of the Minidoka Project, comprising some 77,000 acres, came into existence and began the delivery of water in 1954. Private development and lands leased during the testing years had wasted water through natural draws and into "lows" where Canada thistle had gained a tremendous foothold and had been seeding for several years. These seeds had been scattered by wind, and when water was applied to the thirsty acres, the seeds were

Fried chicken, cake, soft drinks—all the food you can get is served on Weed Emphasis Day.

ready and Canada thistle plants became a part of the first year's crop.

After some discussion by concerned people, a county weed and insect committee was formed in 1960, with the county weed supervisor as chairman and the county agent as recording secretary. Other members included farmers from both irrigation districts, a representative from a weedicide dealer and the irrigation manager of the North Side Pumping Division. The committee was set up as a steering body responsible to promulgate a program of education and responsibilities in Minidoka County in relation to the identification and control of noxious weeds.

This committee, in searching for means and methods, studied the *Weed Idenification Day* plan the Bureau of Reclamation was using annually on the north side and decided to adopt and enlarge the idea. In this way, *Weed Emphasis Day* on a countywide basis became the special feature that it is.

Minidoka County insect and weed committee is also using the radio and newspaper media for timely information dissemination, with the county extension service issuing news releases on insect and weed control methods pertinent to the county. # # #

(SPAIN. *Continued from page 3*)

The arch, which spans the major portion of the valley, was designed by the Bureau of Reclamation's method of trial-load analysis in which the stresses due to the weight of the dam, hydrostatic pressure, uplift, temperature variation, and earthquake were considered. The static behavior of the dam was analyzed in a three-dimensional model at the Central Laboratory of Soils and Materials of Construction of Madrid and in models at the National Laboratory of Civil Engineering as Lisbon, Portugal.

The power installation at Belesar is also underground. Three 13-feet-diameter penstock tunnels lead to an underground powerplant.

Spain, like the United States, is taking advantage of many other new frontiers of development and control of precious water resources. As the importance of this everyday commodity in life looms greater before growing populations, I feel that it is to our mutual advantage to keep the avenues of communications open between our two nations, as well as other forward looking people and governments, and be ready as neighbors to improve our conditions, and work harder as friends for prosperity and peace. # # #

A poet hears the song of manmade things. Over the years, Elma Hill Neal and her Reclamation employee husband Edgar H. Neal have had meaningful experience with irrigation and have contributed many articles to the *Reclamation Era*—Ed.

The Waters of Idaho

I sing of my past as I sing of thee
You waters of Idaho;
You hushed still lakes, you roaring rivers;
You little seeps where the cattails grow.

You are many and varied, you waters that glide
Through this wild and tilting terrain;
You black lava gorges, you foaming falls,
You rivers that sink in wide grassy plain.

But my life has been lived by a lesser stream
That curves through alfalfa and sage;
It is throttled by gates and meted by gage
And is a part of the great western dream.

Born of the snowfields and mountain fed springs;
Child of the rivers and lakes;
Giver of life as the long season swings
And meadow and field awakes.

You are the wide canal; you are the little ditches;
Surging with brown water, rimed with green algae;
Soaking the long furrows, bringing riches
Untold, O you waters of Idaho.

—by *Elma Hill Neal.*

Reclamation in the Rio Grande Area Aided by Watershed Work

by HERBERT I. JONES, Soil Conservation Service, Denver, Colo.

Editor's Note.—This article by Mr. Jones describes the Soil Conservation Service effort and controlling hand on Nature's wrestling with water and soil—so meaningful to the security of the farmers and urban residents in three of New Mexico's southern counties.

The Bureau of Reclamation's Rio Grande project area totals 196,538 acres, of which 102,100 are in these valley lands in New Mexico. Water users in the area benefit substantially by the contributions of SCS control of sediment, erosion, and flooding of project lands. SCS developments are on tributary arroyos and creeks adjacent to Bureau project lands.

In utilizing flows of the river, these Reclamation project facilities produce electric power for the area and irrigate lands which in 1963, produced crops valued at $25,464,000.

Along the 100-mile stretch of the Rio Grande in southern New Mexico work is well underway in the protection of valuable reclamation work, farmland, and property from the destructive floods that have cost the rich valley millions of dollars in damages over the years.

The constant threat of floods kept land values down and taxes up, curbed community expansion, and made farming an extremely risky business in the vicinity of arroyos.

All this is changing. And though the start of the change began in the late 1940's as neighbors began pooling efforts to push the work, the big step forward can be traced to 1954 when Congress passed the Watershed Protection and Flood Protection Act (Public Law 566). Through this act Congress authorized the Department of Agriculture to work with local sponsors in the preparation of plans to design and construct flood prevention work on watersheds under 250,000 acres in size. The Soil Conservation Service was charged with administering Federal funds for planning and construction. Sponsors were to take care of easements, maintenance, land treatment, and varying shares of the cost of water management improvements.

The bill was hardly enacted when a flood hit Garfield, N. Mex., a village located along the Rio Grande in northwest Dona Ana County. The banks of the Garfield lateral were washed out delaying water delivery to scores of farms and drowning crops on others. More than 18 inches of water and mud swilled across U.S. Highway 85, into homes and business places.

Directors of the Caballo Soil Conservation District, Garfield folks, and their neighbors farming at the mercy of Velarde, Salem, Reed, Ralph, and Rodey arroyos applied for Public Law 566 help for what is known as the Hatch Valley arroyos project. Work on six floodwater dams, one on the Garfield arroyo, began within a year. The local groups agreed to underwrite nearly one-third of the estimated $185,000 installation cost and to operate and maintain the project for at least 50 years.

The contract for building the $35,000 North Salem floodwater dam became the first in the Nation to be signed-sealed-and-delivered under the new program. In all, the Hatch arroyo structures have more than 1,100 acre-feet of capacity to take the brunt of flash runoff while the controlled release of floodwaters is made through the established drains and wasteways of the Elephant Butte system.

At the same time directors of the Elephant Butte Irrigation District found they could employ law 566 and sponsor projects to safeguard immensely valuable irrigation improvements built over a span of nearly 50 years by the U.S. Bureau of Reclamation. The board immediately moved to sponsor the Dona Ana Arroyos watershed project located 25 miles down river from the Hatch project and north of Las Cruces, N. Mex.

This 7,000-acre project was designed to protect 24 farms and improvements. It includes two flood prevention dams close by the Dona Ana lateral and the key Leasburg Canal, with a "controlled-water" floodway to the Rio Grande. An-

nual benefits accruing are estimated at over $20,000—not a surprising figure considering crop values in the potential damage area average over $185,000 a year.

Much of the upswing in watershed activity along the Rio Grande is attributed to the progressive directors of the Elephant Butte Irrigation District, headed by president, W. H. Gary, and assisted by district manager, John L. Gregg. Under the guidance of these men a cluster of small watershed projects and individual jobs virtually ring the 100-mile-long valley.

Six authorized projects covering 18 arroyos are either completed or in construction with Public Law 566 funding. At least 24 more projects are in some stage of planning. And the list of applications is perhaps double that figure.

Channels Became Blocked

Most of the side arroyos causing trouble along the Rio Grande probably once had natural channels emptying directly into the river. Deposits then were conveniently swept away during river floods. But gradual aggradation of the river blocked the channels so that virtually all tributary runoff now floods cultivated land.

The six arroyos making up the Hatch project are probably prime examples. At least once every 4 years severe damages occurred in their vicinity following late summer and fall thunderstorms. About 750 acres were hurt as water ponded up to 3 feet in depth. Almost always the Garfield lateral or Hatch drainage ditch banks eventually broke to release part of the water. But some damages could occur on as many as 2,000 acres. Railroads, highways, fences, buildings and equipment, and stored crops were subject to damages. Livestock invariably suffered.

A second category of arroyos being treated are those that interfere with irrigation and create expenses by their direct access to the river in contrast to those with no outlet to the river.

The Rio Grande channel through the Hatch-Mesilla Valley is maintained by the U.S. International Boundary and Water Commission as part of our treaty responsibilities with Mexico. Canalization work begun in the thirties prevents the river's wandering to and fro, losing water at every turn to phreatophytes and sand strata as it once did. But the straightening has intensified the need for side arroyo control in some special places.

Growth of a Mesilla Valley cotton crop on floodplain land in Dona Ana County, N. Mex., being inspected by Husin Ali, Indonesia. (Soil Conservation Service photo.)

Debris deposits from these tributaries can do severe damage directing the riverflow against a levee, by checking the channel and by forcing sediments into the Elephant Butte irrigation system.

Removal of the nuisance material is getting more and more expensive. And there are fewer places for spoil banks as land use in the valley becomes more intense. Recently it was necessary to rent considerable acreage for waste material from one reach of the river. Costs of trucking to off-river dumps is prohibitive, but it must be done where material can no longer be profitably used.

How well arroyo watershed projects have done their job of keeping debris from choking the canalized river is evidenced by the IBWC's willingness to fund planning. The agency has agreed to help with 11 arroyo plans and will contribute about $10,000 toward each. Commission officials are convinced that their work is sufficiently protected

to allow the Commission also to help with maintenance.

If John Gregg, secretary-manager of the Elephant Butte Irrigation District, has a favorite among the two dozen projects he is helping to develop, it is probably the Tortugas watershed.

This problem watershed originates on the mesa slopes east of the New Mexico State University campus, runs hard-by the college airstrip and in its old ways, took a wandering course to spread floodwater this way and that, seemingly never making any real attempt to reach the river.

As late as 1962, the "distributary" covered several hundred acres—a tangle of mesquite and salt bush hummocks. The area would have been bigger if the banks of the Las Cruces lateral canal would have held. But these washed out regularly to drain silt burdened water through the irrigation system that serves some of the most productive land in the Mesilla Valley. At least once every 2 years and occasionally twice a year, 1,000 feet or more of the lateral would be filled with sediment and debris.

With the lateral out and 16 farms flooded, 1,700 acres down the ditch were without water until emergency repairs could be made.

Mr. Gregg pointed out recently an innocent enough looking ditch south of Las Cruces. He explained this was the channel for the controlled release water of the earthfill Tortugas Dam. The dam was barely visible 2 miles to the east where it blended in with the semidesert shrubland that makes up the 15,584-acre watershed.

Traps Flash Floods

The 41-foot-high structure traps around 1,300 acre-feet of flash runoff, and through its always-open concrete spillway, meters out floodwater slowly enough to allow safe delivery through the constructed channel. Over 405,000 cubic yards of earthfill went into the construction of the dam.

One interesting facet of watershed construction on the Tortugas arroyo is the way the project has freed New Mexico State University from the encroaching urban development of Las Cruces by providing access to an area east of the campus. Increased values of land now available to the university for use and development is estimated to be double the more than $1/3 million cost of the project.

So long as the Tortugas was apt to run uncontrolled it was not practical to expand university developments to the south.

John Gregg says, "Tortugas paid for itself the day it was finished by enhancing the land values between the detention dam, the university campus, Interstate Highway 10, and the valley cropland." According to Gregg, upward of 600 acres of creosote bush range jumped from a $50-an-acre value to not less than $500 an acre.

One important role of the watershed dams is in timing released floodwater to the river. Prolonging runoff and peak riverflows results in water credits for the Elephant Butte project. The slowed, anticipated water is useful to the Texas irrigators. But uncontrolled flood runoff with extreme and short-lived peaks is not counted as water delivery below the dam and on the Texas side of the State line.

The structures are also contributing some other interesting side benefits. One is the safety provided the Santa Fe Railroad at low arroyo bridges. Over the years clearance at these was reduced by accumulated rock from the desert pavement so that water-activated signal lights were needed along the tracks at danger points to warn traincrews of flood dangers.

Santa Fe officials were among the first to see the potentials of Public Law 566 arroyo control. To start things off, the railroad contributed $3,000 toward the Hatch project.

Planners working on Interstate Highway 25 visited SCS and EBID officials numerous times to locate routes that would avoid completed watershed structures and construction sites.

The projects, though they help the irrigation district, the university, railroads, highways, business, industry, municipal development, and whole communities, come in for highest praise from individuals they aid.

Watershed project work has given some landowners an opportunity to build better farms and perhaps stay in business in the face of stiff competition.

Some of these men who have found themselves with less than efficient units considering the ability of modern equipment and methods have actually enlarged their farms and their abilities by soil swapping. Under this scheme they have taken old sand-choked channels, not needed after watershed construction or river canalization, and added heavy soil from other parts of the farm—back hauling sand to the too heavy land.

The crops one farmer grew the first year after he "swapped" brought in a thousand dollars more

than the job cost. More important in the long-run conservation effort, was the economic water distribution which reshaping is permitting.

High grade leveling, benching, ditch lining, pipelines, and other improvements are now practical on many farms. The result is a saving and better use of irrigation water, supplies, and labor where once the danger of flooding precluded these improvements.

The same enthusiasm for arroyo protection carries down river beyond the city of El Paso, Tex., to the Diablo Canyon and Camp Rice projects that were among the earliest small watershed treated in Texas with Public Law 566 help. One special benefit of these projects beyond the protection of agriculture and water resources is that afforded to highways and the Southern Pacific Railroad. So critical was the railroad's need that officials readily agreed to move 5 miles of mainline trackage to permit the building of one dam.

Recently an engineer representing the Texas State Highway Department reported cost of Interstate Highway 10 bridges across the Alamo and Diablo arroyos was half what it would have been without the floodwater detention structures.

Cities are not immune, either. A leading attorney in El Paso drowned in an arroyo near his home when his car was stalled and then swept away by a sudden flood of runoff across a residential street.

El Paso, taking a tip from some of the smaller communities, began long-range watershed protection and flood control in 1960, with $2,149,000 of construction work. Commissioner Joseph Friedkin of the IBW Commission was chairman of the mayor's advisory public works committee.

Floods in the city are spectacular, affect many people simultaneously, and are costly to correct. The cost of flooding in areas like the Hatch-Mesilla Valley can run into millions of dollars each year and affect thousands of people. There is still time for landowners in the farming areas to do something to help correct their flood problems. In the Rio Grande Valley, citizens aided by Public Law 566 are sharing the costs and shouldering the burdens of doing just that. # # #

RAIN GOD

This strange rain god was captured by Bureau engineers behind Glen Canyon Dam in Arizona. It measures 203 feet from top to bottom. Its habitat ranges from all over the upper Colorado River basin, to Lake Powell behind Glen Canyon Dam. To liquidate the rain god naturally, rotate picture to your left.

Demonstrating at the Ransom and Deep River Development Farms . . .

PRODUCING MORE WITH LESS LAND

by R. E. DOROTHY, Chief, Irrigation Division, Bismarck, N. Dak.

There is a whale of a lot of difference between dryland grain farming and diversified irrigated agriculture, and North Dakota's two irrigation development farms are providing many of the answers that will be needed to make the change-over as smooth as possible. Located at opposite ends of the sprawling Garrison Diversion Unit, separated by some 250 miles of prairie farmland, the two development farms have demonstrated that irrigation is a good business in North Dakota and have provided on-the-spot irrigation demonstrations to area farmers.

The Ransom development farm near Sheldon, in southeastern North Dakota and the Deep River development farm, located in the northern portion of the State some 50 miles northeast of Minot, were established by the Bureau of Reclamation, in cooperation with North Dakota State University, as part of the Missouri River Basin project's Garrison Diversion Unit. A third development farm in the central section of the State near Sheyenne, N. Dak., was operated for 5 years, but was discontinued in 1961 after it had served its purpose.

Ransom Development Farm

Situated in the heart of North Dakota's corn belt, the Ransom development farm is providing firsthand information on what irrigation can do in the southern portion of the huge Garrison Diversion Unit.

When the farm was established in 1958, Argil Froemke and his wife, Holly, not only leased their farm to the Bureau of Reclamation for development farm purposes, but were picked from a field of 15 applicants to operate it. A young hard-working couple, the Froemkes have not regretted their decision to act as contemporary "pioneers" in their community, and the results of 6 years of irrigated farming tells why. While their neighbors have been buying land to create larger and larger units to meet the challenge of the farm-price "squeeze," the Froemkes have been able to more than double the size of their cattle-feeding operation through the increased feed supply produced with irrigation without adding a single acre to their holdings.

The development farm site was selected in 1957 by an unofficial committee representing the Bureau of Reclamation, North Dakota State University, and a group of interested and successful dryland farmers representing the southeastern portion of the State. After surveying several possible sites, and considering such factors as soils, topography, water supply, farm buildings, and availability for lease, the committee selected the Froemke farm on the Sheyenne River, 6 miles south of Sheldon. The Bureau then entered into a 5-year cash lease with the Froemkes to use their property as a development farm, and began developing the irrigation system.

After the site had been selected, a talent hunt was instigated to locate a qualified farm operator who would be interested in the operation on a crop-share basis. Since part of the justification was to show local farmers what irrigation could do in their area, it was decided that the man operator should be a dryland farmer with no previous irrigation experience. The fact that he would have to learn how to irrigate put him on the same basis as all the potential irrigators in the State. This, then, would be a true test of what an average "dry-lander" could do with an irrigated farm. After screening 15 applicants, and studying in detail the qualifications of the 7 finalists, Froemke was selected.

One hundred and thirty-six acres of the 365-acre farm were leveled in the fall of 1957, and provided with the necessary ditches, drains, and structures to provide a gravity irrigation system. The water is pumped from the adjoining Sheyenne River using electric power from the Cass County Electric Cooperative as an energy source. All costs

An aerial view of Deep River Development Farm.

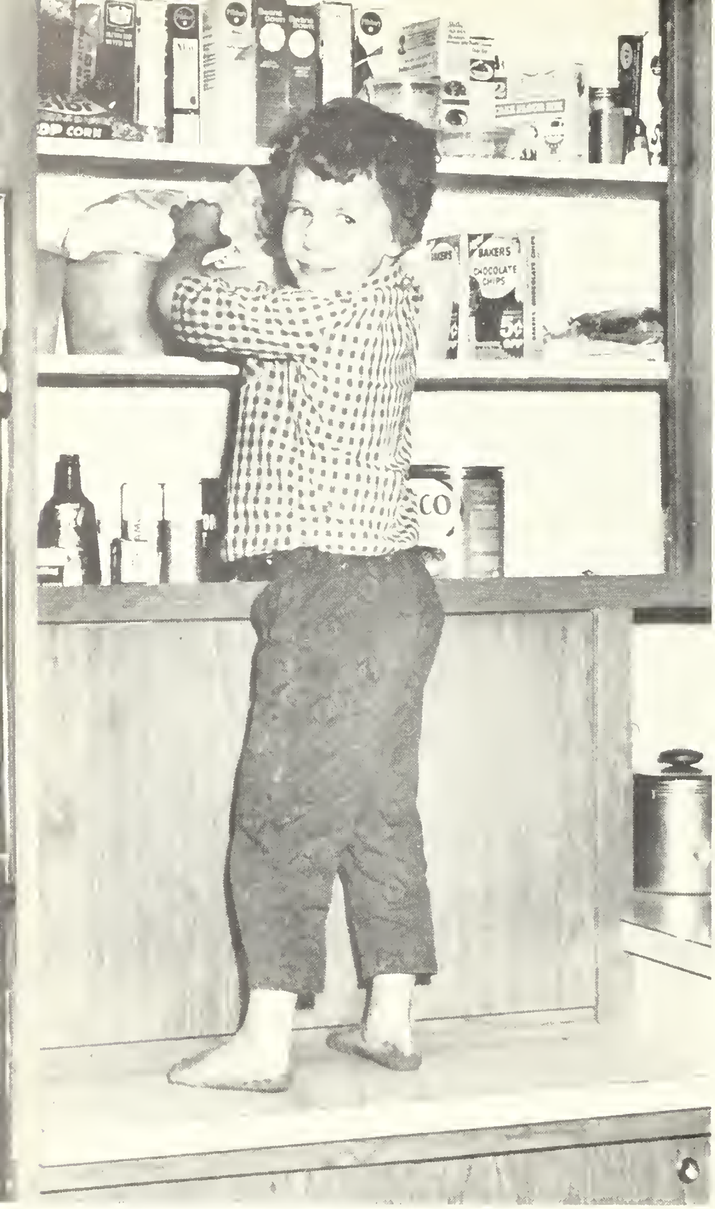
of irrigation development were paid by the Bureau of Reclamation, under the terms of the farm lease. In addition, the Bureau provided a farm ditcher, float, and two-way plow for Froemke's use.

With the farm under construction and an operator selected, the committee was formally organized as the Ransom Development Farm Committee. The committee turned its attention toward the formulation of annual operating plans. While its recommendations have no official status, and are not binding on the operator, the committee has been very effective in assisting with the year-to-year planning of farm operations. Earl Sulerud, Ransom County Extension Agent, acts as the secretary of the committee and has called regular meetings to discuss the past year's results and next year's plans. Items such as crop varieties, fertilizer plans, feeding rations, tillage practices, weed control, and similar subjects are discussed.

During the past 6 years, the irrigated yields have steadily increased and have surpassed the most optimistic estimates, due partially to the combination of good soil, water, fertilizer, and climate, but also due in a large measure to the high degree of management exhibited by the Froemkes.

Yields of corn for livestock feed have climbed from 60 bushels in 1958 to an average of 108 bushels per acre for the past 2 years, compared with the county dryland average of 30 bushels per acre. Corn silage has averaged 20.4 tons per acre over the past 5 years, with the county dryland average amounting to about 5.3 tons per acre for the same period. Similar results can be shown for alfalfa hay, where the irrigated production averaged 5.5 tons per acre against the county dryland average of 1.5 tons. Durum wheat, used as a nurse crop for alfalfa, has averaged 33.6 bushels per acre. The dryand average for durum in Ransom County is around 20 bushels.

At the time the farm was established, the Froemkes maintained a 50-cow beef cattle herd, pasturing the cows in a U.S. Forest Service coop-



Was there ever a barefoot farm lass who did not know how to get up to the cookie jar? Kristen Froemke, age 4½, knows how. She is one of six Froemke children.

erative pasture during 6 months out of the year. They were able to produce feed to maintain the cowherd over the winter and to fatten the year's calf crop. With the increased feed supply available from the irrigated production, the cowherd was increased to 60 head, the maximum Froemke is permitted to graze in the cooperative pasture. In addition to placing his own calves in the feedlot, he has purchased additional feeders each year to increase his feedlot population to around 125 head.

Approximately half (70 acres) of the irrigated acreage on the farm is planted to corn for livestock each year, with about 20 acres chopped for silage and the remaining 50 acres picked for corn grain.

The use of preemergent chemical weed spray, applied at planting time in 14-inch bands in the corn rows, has been practiced for the past 3 years, and has resulted in the elimination of corn cultivation except for the irrigation-furrowing operation. Needless to say, the elimination of cultivating has saved many valuable hours during the peak-labor-demand period and, according to Froemke, has increased his corn production by the elimination of root pruning by the cultivator.

The North Dakota Agricultural Experiment Station's Department of Agronomy has conducted hybrid corn variety trials at the Ranson development farm since 1960, in conjunction with similar trials on dryland farms in various locations throughout the State. These trials have produced an abundance of information on the performance of various hybrid corn varieties that heretofore was not available for irrigated corn in North Dakota.

At least one organized public tour of the farm is held each year, to provide the interested public with an opportunity to witness the resutls obtained.

In addition to the organized public tour, there are many special group tours each year by such groups as the agricultural engineering class of North Dakota State University, local service clubs and others. Many persons visit all through the crop season, just to drive around the roads surrounding the irrigated fields and possibly to make mental comparisons of the lush stands of irrigated crops with their own dryland crops. Each year teachers attending summer school at the Conservation Camp at Lake Ashtabula, near Valley City devote a half day of their curriculum to a tour of the development farm. Many of the teachers have never seen a gravity irrigation system in operation prior to their visit.

It is interesting to note that the introduction of irrigation on the development farm has resulted in the establishment of irrigation systems on several other farms in the area where a water supply either from wells or from a river was available. Two years after the project was established Froemke's neighbor to the south developed 20 acres for irrigation adjoining the development

Froemke has leased the 200 acres for the 1964 season on a crop-share basis and will irrigate 336 acres this season.

"I will have to hire a full-time hired man," Froemke said, "but I will be able to support a cowherd of around 120 to 130 head which means I will be able to produce my own calves." In order to provide adequate pasture for his increased herd, he has seeded 30 acres to irrigated pasture this spring. This, along with his dryland pasture and the 60-head grazing quota in the cooperative pasture, should be sufficient for his enlarged herd.

Argil's wife, Holly, besides mothering their six children (ages nine years and younger), has devoted a large share of her time lately to planning and decorating their new modern split-level farm home. Electrically heated, the house represents several years of careful planning and "idea collecting." "We're finishing it off as we can afford it," said Argil. "We lived in the basement and first-floor family room for the first few years, but last year we finished the kitchen and living room. This fall we will get the outside siding, and next year we hope to finish the job by completing the upstairs bedrooms and bath."

The Lisbon, N. Dak., Junior Chamber of Commerce selected Froemke as the Ransom County Outstanding Young Farmer for 1962, and presented him with a handsome plaque and a trip to Mandan to compete in the State contest. It is significant to note that this was the first such award ever presented in Ransom County.

The farm-lease agreement was revised in 1961 to eliminate the lease payments by the Bureau and the crop-share payments by Froemke. Under the new agreement the Bureau furnished the irrigation water, specialized irrigation equipment, and some weed-control chemicals. In return, Froemke agreed to a development farm operation to furnish data on yields, fertilizers, water use, and related items. He also agreed to provide research plots for irrigation research, and to cooperate with the Bureau and extension service in making the farm available for public tours.

"It's a lot of work," says Argil, "but with irrigation water available I know I won't have to stand helplessly by and watch my crops wither away in the dry-hot periods. It would be very difficult for me to return to dryland farming after these past 5 years of the irrigated type."

Argie Froemke makes good use of water for his corn. He also believes in good farm recordkeeping.

Deep River Development Farm

The Deep River development farm was established in 1953 to demonstrate the feasibility of irrigation in the Souris area; a 500,000-acre block of irrigable land extending south from the Canadian border in the north central part of the State. In the early years, this farm was operated on a crop-share basis by a local dryland operator, to show what other local farmers might accomplish with irrigation on their own places. The lease arrangement was modified in 1963 to eliminate the crop-share provisions and to provide for the farm operator to pay for the lease rentals, with the Bureau of Reclamation furnishing the irrigation water, specialized irrigation equipment, and the buildings.

In 1957, William H. Sallee moved from his own dryland farm near Granville, N. Dak., to take over the operation of the Deep River development. Bill, as he is known throughout the area, is one of the very few Negro farmers in North Dakota. Raised on his father's homestead near Granville, he later took over the Deep River farm and established a sound reputation as a good farmer and cattle feeder.

Bill learned very early that irrigation farming was different in many ways from the dryland operation he was used to, but it did not take long before he was handling the situation like a veteran irrigator. Active in civic and community affairs, he is currently chairman of the Upham PTA unit, chairman of the board of directors of the Middle Souris Irrigation District, and represented McHenry County as a delegate to one of the State political conventions in 1964.

Irrigation water is pumped with a propane-powered pump unit from an arm of Deep Creek, a part of the Lower Souris National Wildlife Refuge. Four cubic feet per second are furnished to a distribution box, near the farm buildings, from which it is turned into several different ditches leading to the various fields. All irrigation is by gravity, with several different-sized siphon tubes in common use.

Basically a cattle feeding and fattening enterprise, the farm produces alfalfa, corn silage, and feed grains on the 136 irrigated acres, to feed the 125 head of feeder cattle usually found in the feedlot. Small grains and potatoes are also grown as cash crops.

The Agricultural Research Service and the North Dakota Experiment Station utilized portions of the farm for irrigation research during the period 1953–58. ARS produced a large quantity of valuable data on fertilizers, water requirements, crop varieties, tillage practices, irrigated pasture management, and other facets of irrigated agriculture in the Northern Great Plains.

An unusual problem encountered at the Deep River farm is that of crop damage by blackbirds from the nearby Lower Souris National Wildlife Refuge. During the drought year of 1961, when it was one of the very few "green spots" in the entire county, the blackbirds could be counted by the thousands, feeding on the grains and causing extensive damage. Acetylene "cannons" firing at preset intervals were later used with some success in the fields to scare the birds away.

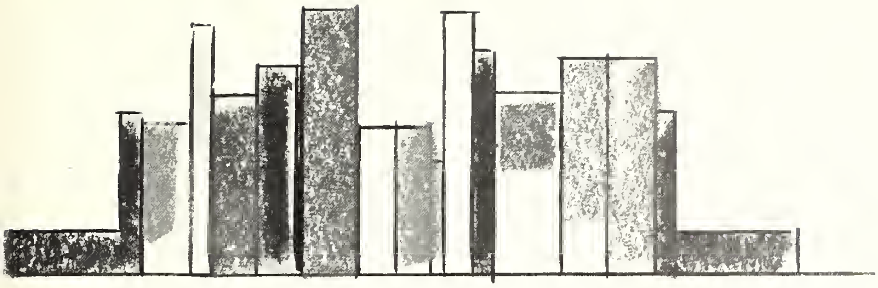
However, production and yields have demonstrated to area farmers that irrigation in the Souris area is a paying proposition. Average yields during the 1957–63 period show that irrigated corn silage, alfalfa hay, and potatoes have exceeded county dryland yields by a ratio of 3 to 1 or more.

Other irrigated crops have shown similar yield increases. The many visitors, from all over the State, who tour the farm each year attests to the interest in irrigation.

As is the practice at the Ransom development farm, a sense of local participation in the farm operation is achieved through a development farm committee, composed of successful local dryland farmers who help formulate farm plans each year, with the assistance of the State extension service and Bureau agriculturists. Items such as cropping plans, plant varieties, fertilizer requirements, tillage practices, weed control, and many other similar subjects are discussed with the committee, and general recommendations made.

Alvin Kramer, Ward County Agent from Minot, and who acts as secretary to the committee, said that the farm has created a lot of interest in irrigation in Ward, McHenry, and Bottineau Counties during the past few years. # # #

Bill Sallee, operator of the Deep River Farm, checks his cattle being fattened by feedlot.



BOOKSHELF *for water users*

Laboratories Booklet Gets 1964 Revision

A revised booklet on the facilities, work accomplishments and organization of the Engineering Laboratories, Division of Research of the Office of Chief Engineer, Denver, Colo., has been printed. It is an illustrated publication containing 16 pages, and is size 6 by 9 inches. The booklet is available from Bureau distribution centers and the Superintendent of Documents, Government Printing Office, Washington, D.C.

Monograph No. 33 is Printed by GPO

Engineering monograph No. 33 entitled, "Hydraulic Design of Transitions for Small Canals," printed in 1964 by the Government Printing Office, is available through the distribution facilities of the Superintendent of Documents, GPO, and the Office of Chief Engineer, at price, 35 cents. The illustrated, 39-page publication is the second engineering monograph to receive Printing Office handling. It is based upon information originally reported in "Hydraulics Branch Laboratory Report No. 492."

IAHR Congress Report Is Published

A detailed report of the proceedings of the 10th Congress of the International Association for Hydraulic Research, which was held in London, England, has been published and deemed valuable technical reading in hydraulogy matters. The 307-page report was prepared by Alvin J. Peterka of the Office of Chief Engineer. Copies are available from that office.

River Book Translated From Polish

An English translation of *River Regulation*, a technical Polish book, has become available. The translation was made for the Department of the Interior and the National Science Foundation under provision of Public Law 480, providing for the translation of foreign information pertinent for use in this country. Under this law, surplus foreign currencies from the sale of surplus agricultural products are made available for translating technical literature. The 380-page volume was written by Dr. Wiktor Mamak, a professor at Warsaw Technical University, and was published by Arkady, Warsaw. Copies have been distributed to the regional offices and the Office of Chief Engineer. Others are available from the Office of Technical Services, U.S. Department of Commerce, Washington, D.C., at $3.75 each.

'Mermaids' Studied for Deweeding Waterways

A 3-year study of manatees and their usefulness in controlling aquatic weeds has just been launched by the Central and Southern Florida Flood Control District.

Scientists from Florida Atlantic University at Boca Raton are directing the study, under contract from the Flood Control District. The FCD will pay $34,000 to the university to find out just how many weeds manatees can eat, to study their rate of reproduction, and to learn whether or not the beasts can be used practically and economically as a means of biological weed control.

Newspaper accounts of the manatee report that it is the animal which woman-hungry sailors thought was fish-tailed femininity rising conveniently from the sea, and so the first name given to it was sea maiden or mermaid. Later when sailors got closer looks, the animal was called the "sea cow."

Unofficial accounts have been seen to the effect that the United Nations Food and Agriculture Organization study indicates that the "sea cow" probably could clear some of the world's lakes, canals, and waterways.

For more than 2 years FCD officials have been investigating the possible use of the mammals. They have been gleaning all the information available, worldwide, via correspondence and meetings with university professors, museum curators, Federal and State officials, and authorities of foreign governments.

"Oddly, scientists know very little about manatees," Horner of the FCD explained, "except that they are strict vegetarians, and they apparently consume vast quantities of weeds."

It was reported that some of the mammals were being used effectively in canals of British Guiana. Apparently they are sensitive to cold and will die in water colder than 70°.

Horner has been spearheading the preliminary investigation concerning manatees. He has met with Federal officials in Washington, and went to Chicago to meet with one of the world's greatest authorities on manatees, Dr. Joseph Curtis Moore, Curator of Mammals, Chicago Natural History Museum. Dr. Moore urged Horner and the FCD to sponsor the study, but cautioned that competent scientists should be in charge. He advised that the study should last at least 3 years so that meaningful, quantitative scientific data could be obtained.

An air-breathing creature, the manatee normally surfaces only once every 10 or 15 minutes, then merely pokes the tip of its gray nose out of the water. Unless a person is looking right at the spot where the manatee surfaces, he may never see one of the creatures.

The pilot study as proposed by Florida Atlantic University, calls for six manatees. But the Seaquarium boys consider themselves lucky to have netted five on the expedition.

They struggled for hours to capture the beasts

which fought and thrashed to escape the nets and the men in the little boats.

After the mammals were brought back to the Seaquarium, their lengths, girths, and weights were recorded as follows:

1. Female, 11'4" in length; girth 9'4"; weight 2,170 pounds.

2. Female, 7'2" in length; girth 4'8"; weight 337 pounds.

3. Female, 7'9" in length; girth 5'6"; weight 384 pounds.

4. Male, 7'6" in length; girth 7'4"; weight 871 pounds.

5. Female, 8'9" in length; girth 8'5"; weight 1,312 pounds.

The Seaquarium hoped to net a sixth manatee later.

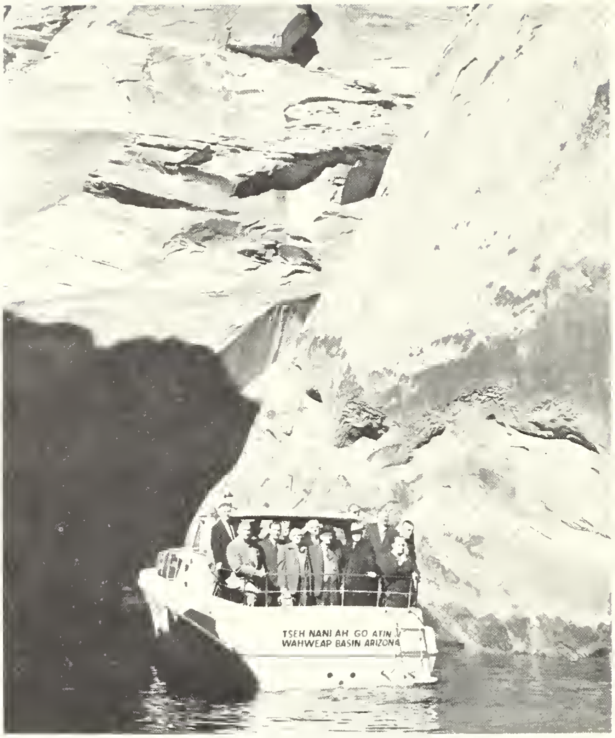
Loaded into wooden boxes, filled with water, the manatees were transferred by trucks from the Seaquarium to the selected FCD canal. They are now busily at work eating weeds.

It is said that manatee meat makes good eating as steaks. But under Florida law, a stiff fine and jail term await anyone who molests or kills one.

It's hoped that the new study will help in preservation of the manatee—now threatened with possible extinction—as well as providing a new answer to weed control problems in Florida.

If the study proves as successful as many authorities believe, it may be that the homely sea cow will be put to work—not only in Florida—but in tropical and subtropical countries around the world—eating its favorite diet of water weeds, and helping humanity while growing fat and happy in flood control and irrigation canals.

But, due to the manatee's environmental requirements, it is doubtful that it would thrive in the colder irrigation waters of the western United States. # # #



Solons View Impressive Red Sandstone Cliffs

Amid expressions of awe and rapture, 11 Congressmen, a Senator, and Commissioner Floyd E. Dominy took a boat trip on November 8 along 50 miles of "the most incomparable water wonderland anywhere in the world."

That is the way Commissioner Dominy described Lake Powell, the reservoir created by Glen Canyon Dam in Arizona. The party embarked at Wahweap Marina and were served lunch in South Sea Island style on a small island. Those present, in addition to the Commissioner, were Senator Carl Hayden of Arizona, Congressman Walter E. Rogers of Texas, Congressman Mike J. Kirwan of Ohio, Congressman Wayne Aspinall of Colorado, Congressman Joe Skubitz of Kansas, Congressman Laurence J. Burton of Utah, Congressman Harold T. Johnson of California, Congressman Craig Hosmer of California, Congressman Edward R. Roybal of California, Congressman John P. Saylor of Pennsylvania, Congressman J. Edgar Chenoweth of Colorado, and Congressman Morris K. Udall of Arizona. Wives and some staff members also were in attendance.

"Mac," Retired Editor Dies

John J. McCarthy, known among his associates as "Mac," died last September 17, after recurrent heart attacks. He had been residing with his wife at Washington, D.C.

Mac was with the Bureau from 1930 until his retirement in 1960, working up from messenger to doing a fine and creditable job as editor of the *Reclamation Era*. ★ ★ ★

AWARD FOR GLEN CANYON DAM

The Outstanding Civil Engineering Achievement Award for 1964, won in a national competition by Glen Canyon Dam, is presented to Commissioner Floyd E. Dominy, right. Making the award last October 21 in New York City is Waldo Bowman, president of the American Society of Civil Engineers. The plaque will be mounted at Glen Canyon Dam. First *Reclamation Era* announcement of the award being won, was in the May 1964 issue. ★ ★ ★

Autobiography of a Trout

by DON PETERSON of the Wyoming Game and Fish Department

Mr. Peterson, who is stationed at the Tillett Springs Rearing Station, near Lovell, has been employed as a hatchery assistant with the Wyoming Game and Fish Department since 1959. Before joining Game and Fish, he attended Wisconsin State College at Eau Claire, Wis., for 1½ years. In college, Don was a zoology major. He is 29. This writing is reprinted by his permission and that of *Wyoming Wildlife.*

The first thing I remember as I emerged from the egg in which I had lived for 35 days was a red-shirted giant. He was leaning over the basket my brothers and sisters and I had occupied since we had been spawned from our mother. She was part of the cutthroat brood stock at one of the Wyoming Game and Fish Commission's hatcheries.

After we were all hatched out, the fellow in red took us from the hatching basket and placed us in a trough of cold clear water. For the first few days were were all content just to lay peacefully and enjoy the comfort of our new surroundings. But eventually I grew restless and began to swim about and explore my new home. The trough I was in was only about 20 feet long, but it seemed 20 miles the first time I swam its full length. In a few days our red-shirted friend walked along our trough in the hatchery and sprinkled something on the water which, to say the least, frightened us all rather badly. After a few days of this I ventured to see just what he was putting in our home and much to my surprise I saw some of my friends eating these small particles, so I tried one myself and found that it tasted rather good. From then on I looked forward to seeing the familiar red shirt walk by our trough and sprinkle the feed on the water.

As time passed I kept getting bigger and bigger and then one day I was scooped up in a net with the other fish in the trough and placed in a bigger trough which was wider and deeper and gave us more room to swim in. Soon, the size of our food was increased.

At first it was a little difficult to swallow the larger food but in a few days I got used to it. A few of my friends just couldn't get used to it and they were beginning to get a little hungry. Then, one day I overheard two of our friends in red say that it was time we were graded. I didn't know what this meant, but I was soon to find out. The next morning they began to scoop us out of the trough a few at a time and place us in a wooden box with slats placed about a quarter of an inch apart on the bottom. They jiggled us back and forth very carefully. Some of my smaller friends wriggled through these openings in the bottom of the box and fell into the trough. Those of us that were still in the box were placed in another trough separate from our smaller friends. I was kind of surprised to find that all of the fish in my trough were all the same size.

All during the summer we were left in this trough, but when the days began to get shorter and the nights a little cooler, we were moved outside into what our friends in red called raceways.

It was quite an experience to see the sun and the moon for the first time and to see the trees that were beginning to turn a beautiful golden color. About this time the size of our feed was increased to little pellets. We were getting bigger all the time.

I'll never forget the first time it snowed. As the snowflakes settled on the water we all wondered what kind of feed we were expected to eat now.

My first experience with enemies came one day when I was resting near the surface of the water enjoying the bright sunlight. Suddenly, I felt myself picked up and lifted from the water, but by struggling violently I was able to wriggle free from my captor and fall back to the water. One of my finny friends told me I was very lucky indeed to escape the kingfisher who had tried to pluck me from the raceway.

As the days began to get longer and signs of spring began to show, some of us were moved from the raceways and placed into dirt ponds so we could have more room to grow.

Finally, in early summer, the big day arrived. My friends and I were loaded into a large tank on the back of a truck and began the journey to our new home. It was a cool clear mountain stream in the Big Horn mountains in north central Wyoming. After many miles of travel over rough roads, I was dipped out of the tank and placed in the water of the stream and allowed to swim away. As I glanced back at my friend in the red shirt, I noticed a pleased look on his face. He had just released a fine lot of fish to make a lot of fishermen happy. As for myself, I intend to become the biggest cutthroat trout in Wyoming. Maybe some day you may catch me. So long for now, and good fishing. # # #

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-6140	Parker-Davis, Ariz	Oct. 6	Construction of the 12-mile Coolidge-ED-2 115-kv transmission line.	Ryan Electric Sierra Vista, Ariz.	$204,972
DC-6147	Missouri River Basin, Kans.	Oct. 1	Construction of Glen Elder Dam, ntilizing soil cement on upstream slope. Parts A and C.	Bushman Construction Co., St. Joseph, Mo.	13,647,291
DC-6148	Central Valley, Calif	Nov. 9	Construction of 35 miles of concrete-lined San Luis canal, Reach 3.	Peter Kiewit Sons' Co., Arcadia, Calif.	24,175,381
DC-6150	Missouri River Basin, Mont.	Oct. 26	Completion of Yellowtail powerplant, switchyard, dam, and appurtenant works.	Wismer & Becker and Tullar Power Construction, Inc., Sacramento, Calif.	2,967,688
DS-6151	Missouri River Basin, Wyo.	Oct. 6	One 33,333-kva trailer-mounted mobile autotransformer for Region 7.	General Electric Co., Denver, Colo.	157,522
DC-6156	Missouri River Basin, Kans.	Nov. 13	Construction of 1.9 miles of Downs diversion drain	Walters, Kershaw and Morgan, Inc., Manhattan, Kans.	227,470
DC-6157	Central Valley, Calif	Nov. 30	Construction of Wintu pumping plant	Purtzer and Dutton, Reno, Nev.	864,344
DC-6160	do	Nov. 2	Construction of Pacheco inlet channel and 2 miles of tunnel to Sta. 198+65, Schedule 1.	Dravo Corp., South San Francisco, Calif.	4,549,520
DC-6161	Denver, Colo	Oct. 23	Construction of the 14-story Bureau of Reclamation office building at Denver Federal Center.	MSI Corp., Wheaton, Md	5,843,035
DS-6165	Central Valley, Calif	Nov. 12	Four 10,000-kva power transformers for Forebay pumping plant switchyard.	McGraw-Edison Co., Pennsylvania Transformer Division, Canonsburg, Pa.	144,990
DS-6166	Colorado River Storage, Colo.	Dec. 3	Two generator-voltage switchgear assemblies and bus structures, two 1,000-kva station-service power transformers, and two busways for Blue Mesa powerplant.	General Electric Co., Denver, Colo.	104,110
DS-6168	Missouri River Basin, Mont.	Dec. 29	Two generator-voltage, isolated-phase bus structures; two 600-volt station-service feeder busways; and three 750-kva station-service power transformers for Yellowtail powerplant, Schedule 1.	Westinghouse Electric Corp., Denver, Colo.	167,440
DS-6168	do	Dec. 24	Four protective equipment assemblies; four generator-voltage, segregated-phase bus structures; and four switchgear assemblies for Yellowtail powerplant, Schedule 2.	General Electric Co., Denver, Colo.	345,878
DS-6169	Central Valley, Calif	Dec. 7	Eight 230-kv circuit breakers for San Luis switchyard, Schedule 1.	General Electric Co., Denver, Colo.	480,290
DC-6171	do	Nov. 30	Construction of 31 miles of pipelines for discharge line, Main aqueduct, and laterals.	Valley Engineers, Inc. of Fresno, Fresno, Calif.	3,510,381
DC-6172	Missouri River Basin, Wyo.	Dec. 9	Construction of 53.75 miles of first section of Glenrock-Stegall 230-kv transmission line.	Malcolm W. Larson Contracting Co., Denver, Colo.	1,491,599
DC-6175	Emery County, Utah	Dec. 14	Construction of Huntington North Dam and dikes	W. W. Clyde and Co., Springville, Utah.	741,286
DS-6178	Pacific Northwest-Pacific Southwest Intertile, Nev.	Nov. 27	Aerial photographs, surveys and maps, right-of-way plats and descriptions, geology data and reports for the 750-kv direct-current transmission line from Mead substation to Beatty, Nev. (Negotiated Contract)	Merrick and Co., Denver, Colo.	155,240
300C-205	Parker-Davis, Calif	Oct. 13	Construction of a multi-purpose building for Parker Dam school, Parker Dam Government Camp.	Vogel-Austin Construction Co., Phoenix, Ariz.	159,821
300C-220	Colorado River Front Work and Levee System, Ariz.	Nov. 20	Hauling and placing of riprap on bank protection structures, constructing 15 miles of gravel access and service roads, and channel excavation along the Colorado River.	Hall Construction Co., Corona, Calif.	456,235
400C-273	Provo River, Utah	Oct. 1	Construction of earthwork, concrete canal lining, and structure revisions for Provo reservoir canal.	E. Arthur Higgins, Salt Lake City, Utah.	101,717
500C-166	Wichita, Kans	Nov. 10	Construction of three comfort stations and water and sewage systems for recreation facilities at Cheney reservoir.	Dopps Construction Co., Wichita, Kans.	122,002
500C-179	Canadian River, Tex	Oct. 1	Construction of boat launching ramp, roads, and parking areas for public use facilities for Blue West area, Sanford reservoir.	Tco, Inc., White Deer, Tex	157,608
602C-44	Missouri River Basin, S. Dak.	Oct. 19	Construction of buried asphaltic membrane lining in reaches of Angostura canal and laterals, Schedule 1.	R. J. Studer and Sons, Billings, Mont.	177,439
604C-54	Pondera County Canal and Reservoir Company, Montana.	Oct. 23	Repair of diversion weir and apron, Birch Creek diversion works and B. canal.	Kyser Construction Co., Missoula, Mont.	168,140

Major Construction and Materials for Which Bids Will Be Requested Through February 1965*

Project	Description of work or material
Canadian River, Tex	Constructing about 35 miles of 20- to 36-in.-diameter East Aqueduct pipeline for hydrostatic heads of from 25 to 500 ft, pipe to be either reinforced-concrete pressure, pretensioned concrete steel cylinder, noncylinder prestressed concrete, or asbestos-cement pipe. Work will also include excavating a 34-ac-ft reservoir and lining with compacted earth lining, and constructing two pumping plants. Near Borger and Pampa.
Central Valley, Calif	Constructing Little Panoche Creek Detentior Dam, an earthfill structure, about 120 ft higl and 1,449 ft long, and appurtenant features. Or Little Panoche Creek, about 18 miles southwesi of Firebaugh.
Do	Constructing about 63 miles of 6- to 48-in.-diametei Corning Canal pipelines of either reinforced-con crete pressure pipe or asbestos-cement pipe

See footnote at end of table.

U.S. GOVERNMENT PRINTING OFFICE: 1965 O—756-096

Major Construction and Materials for Which Bids Will Be Requested Through February 1965*—(Continued)

Project	Description of work or material
Central Valley, Calif.	Constructing about 9.4 miles of San Luis Canal, Reach 4, with a bottom width of 60 ft, to be lined with 4.5-in. unreinforced-concrete lining. Work will also include constructing bridges, irrigation crossings, and turnouts. Near Huron.
Do	Furnishing and installing three 123 cfs at 60-ft head, vertical-shaft, centrifugal-type pumping units with 2,300-volt synchronous motors, and associated control equipment. Corning Canal Pumping Plant, three miles southeast of Red Bluff.
Do	Completion work for the Mile 18 Pumping Plant will consist of placing concrete for pump embedment and motor support; installing three fixed-flow and three variable-pitch impeller, mixed-flow-type pumps rated at 2,200 cfs each unit at total head of 125 ft at 120 rpm, transformers, and other mechanical and electrical equipment; and applying architectural finishes.
Do	Six 14.4-kv, station-type switchgear; 15-kv isolated-phase bus; two 1,500-kva, 13.2-kv to 480-volt, station-service transformers; and 600-volt non-segregated-phase bus for Mile 18 Pumping Plant.
Do	Constructing about 26.5 miles of Clear Creek South pipelines ranging in size from 8 through 42 in. in diameter for hydrostatic heads of from 100 through 400 ft. Near Redding.
Chief Joseph Dam, Wash.	Constructing about 8,000 lin ft of 33-in.-diameter pipe siphon, of which about 200 lin ft will cross a lake in a buried trench; and constructing about 1,400 lin ft of 24-in.-diameter pipelines. The pipelines will be either concrete pressure pipe, pretensioned concrete steel cylinder pipe, noncylinder prestressed concrete pipe, or steel pipe for heads up to 200 ft. Near Oroville.
CRSP, Arizona	Constructing the Flagstaff Substation will consist of constructing a 61- by 23-ft concrete-masonry service building; constructing foundations; furnishing and erecting steel structures; installing four 345-kv circuit breakers, and associated electrical equipment; and grading and fencing the area. About 15 miles east of Flagstaff.
Do	Constructing the Glen Canyon Dam Visitor Center complex will consist of constructing a one-story steel frame and precast Mo-Sai panels. An auditorium seating about 90 persons will be included in the plan for Schedule No. 1 and will be omitted in the plan for Schedule No. 2. Two elevators each of about 40-passenger capacity will be furnished and installed under a separate contract. At Page.
Do	Additions to the Pinnacle Peak Substation will consist of constructing foundations; furnishing and erecting steel structures; installing one 600-mva, 345/230-kv autotransformer, twelve single-phase, 8,000-kva shunt reactors, and five 230-kv and four 23-kv circuit breakers; and furnishing and installing associated electrical equipment. About 20 miles northeast of Phoenix.
CRSP, Colorado	Constructing 6.3 miles of access road. Work will include grading, structures, and bituminous surface treatment. About 13 miles northeast of Montrose, and about 5 miles north of Junction U.S. 60 and Colorado 347.
Do	Furnishing and constructing about 9 miles of 115-kv, wood-pole transmission line with three 477 MCM, 24/7, ACSR conductors and two 3/8 in. steel strand overhead ground wires. From a point about 6.5 miles northwest of Cimarron, to a point about 1.5 miles southeast of Cimarron.
Do	Furnishing, installing, and testing two 66,667-kva, 0.9-pf, 180-rpm, vertical-shaft generators with direct-connected exciters for Morrow Point Powerplant.
Columbia Basin, Wash.	Constructing Radar Pumping Plant, an indoor-type structure, consisting of a reinforced-concrete substructure and a superstructure of structural-steel frame with insulated metal siding; and furnishing and installing a 20-ton bridge crane to service five electric, motor-driven, horizontal-centrifugal pumping units of 256-cfs total capacity. Provision will be made for future installation of four additional pumping units of 206-cfs total capacity. South of Othello.
Columbia Basin, Wash.	Constructing about 15.4 miles of Wahluke Canal, of which about 3.4 miles will be concrete lined with a bottom width of 16 ft; about 8.9 miles will be earth lined, with a bottom width of 42 ft; and 3.1 miles will be unlined with a bottom width of 42 ft. Near Othello.
Eklutna, Alaska	Constructing a tunnel intake and trashrack structure consisting of a reinforced-concrete base with concrete columns and beams to support metal trashrack bars on three sides and top of structure. The intake structure will be in Eklutna Lake and the work will include cofferdaming and unwatering of the site. Removal of a portion of the existing precast-concrete conduit will also be required. Near Anchorage.
Do	Constructing the earthfill Eklutna Dam, a new dam to replace the existing structure, about 40 ft high and 800 ft long, containing about 82,000 cu yd. The spillway will consist of an intake structure, an ogee crest to be constructed after diversion, an 18- by 16-ft rectangular conduit, a chute, and a stilling basin. On Eklutna Creek, about 34 miles northeast of Anchorage.
Mann Creek, Idaho	Constructing Spangler Dam, an earthfill structure about 138 ft high and 1,120 ft long, containing about 1,000,000 cu yd, and appurtenant features. The spillway will consist of an inlet structure, an 11-ft-diameter conduit and a stilling basin. The outlet works will consist of an intake structure, a 5-ft-diameter pressure conduit, a gate chamber, a 6-ft 6-in. diameter horseshoe conduit, and a stilling basin. Work will also include relocating about 3 miles of county roads. On Mann Creek, about 13 miles north of Weiser.
MRBP, Kansas	Constructing the Almena Diversion Dam consisting of a reinforced-concrete ogee overflow weir about 150 ft long; abutment wingwalls; sluiceway with a 6- by 18-ft radial gate and a constant head orifice-type turnout to canal with two 72- by 60-in. orifice gates, and two 60- by 48-in. turnout gates; and constructing an earth dike about 200 ft long. Near Norton.
Pacific Northwest-Pacific Southwest, Arizona.	One 450/600-mva, 3-phase, 345/230-kv autotransformer for Liberty Substation.
Do	Four 230-kv, 1,600-amp, 20,000-mva power circuit breakers for Liberty Substation.
Do	One 345-kv, 1,600-amp switch; and eleven 230-kv, 1,600-amp switches for Liberty Substation.
Pacific Northwest-Pacific Southwest, Nevada.	One 230-kv, 600-mva autotransformer for Mead Substation.
Do	One 3-phase, 450/600-mva, 345/230-kv autotransformer for Mead Substation.
Do	Nineteen 230-kv, 20,000-mva power circuit breakers for Mead Substation.
Do	Eight 287-kv, 25,000-mva power circuit breakers for Mead Substation.
Pondera County Canal & Reservoir Co., Montana.	Constructing Swift Dam, a concrete thin arch structure about 205 ft high and 560 ft long, containing about 53,000 cu yd, and appurtenant features. The existing spillway, off the left abutment, will be rehabilitated. A new, uncontrolled, 200-ft spillway will be constructed over the crest of the dam. The outlet works will consist of two conduits through the dam controlled by high-pressure gates. On Birch Creek, about 45 miles west of Conrad.
Rogue River Basin, Oregon.	Constructing Agate Dam, an earthfill structure about 77 ft high and 3,800 ft long, and appurtenant features. The concrete spillway will consist of an inlet structure, a variable width open chute and a stilling basin. Work will also include construction of 1,300 ft of 7-ft bottom width Agate Feeder Canal and a Parshall flume. On Dry Creek, about 13 miles northeast of Medford.
San Juan-Chama, Colo.-N. Mex.	Constructing about 8 miles of concrete-lined Blanco Tunnel of either 8-ft 3-in. diameter horseshoe section or 8-ft 7-in. diameter circular section; and constructing the reinforced-concrete Blanco Diversion Dam consisting of an ogee overflow weir, sluiceway, and headworks. On the Rio Blanco, near Pagosa Springs.
Silt, Colo	Earthwork and structures for reconstructing about 6 miles of Davie Ditch to a capacity of 18 cfs, of which about 4 miles will be lined with compacted earth lining. Near Rifle.
Spokane Valley, Wash	Constructing about 84 miles of 6- to 24-in.-diameter pipeline for heads up to about 250 ft. Near Spokane.

*Subject to change.

What's Coming:

DYE DODGES DRY SPELLS

IMPROVE YOUR SALTY SOILS

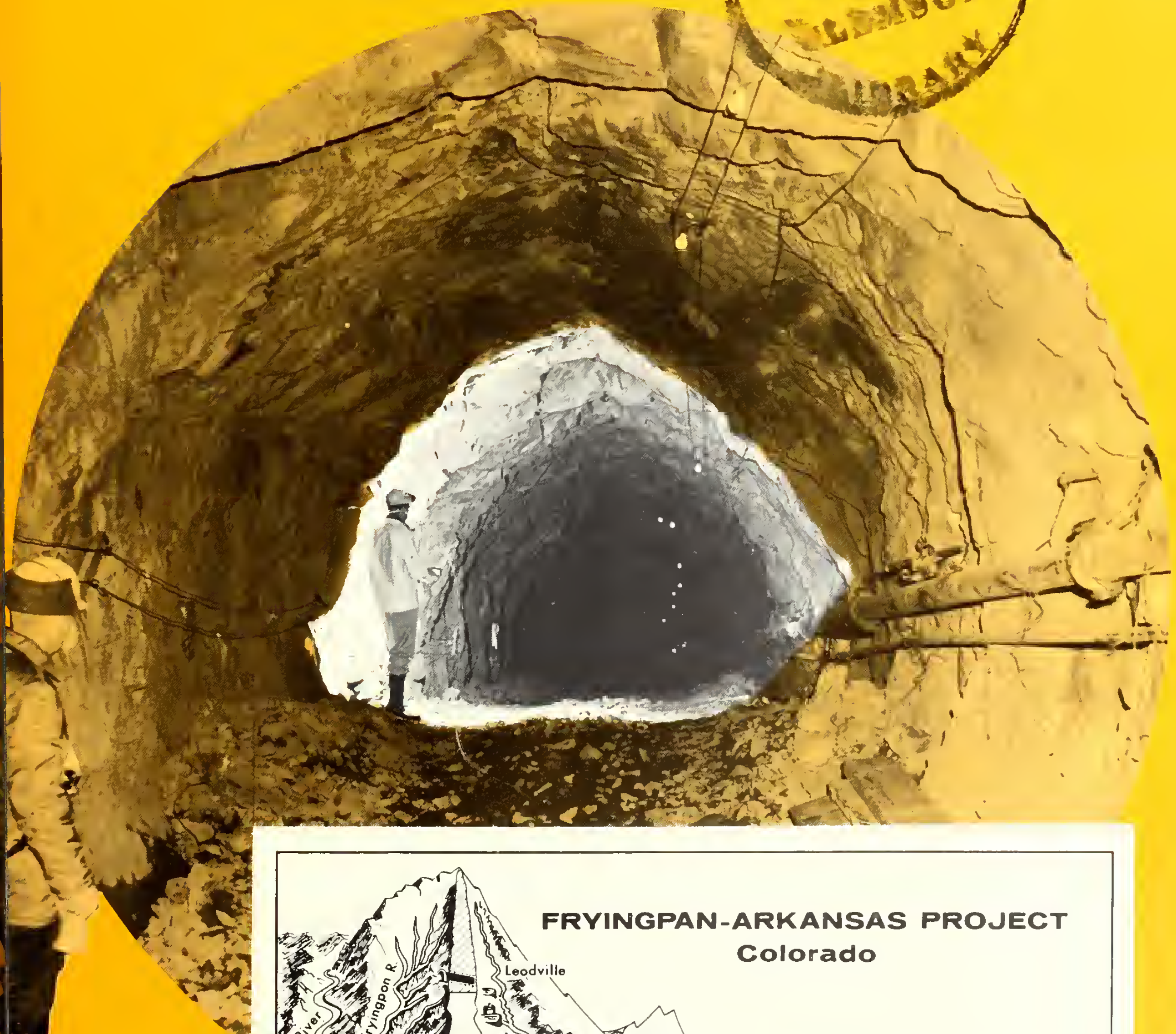
In its assigned function as the Nation's principal natural resource agency, the Department of the Interior bears a special obligation to assure that our expendable resources are conserved, that renewable resources are managed to produce optimum yields, and that all resources contribute their full measure to the progress, prosperity, and security of America, now and in the future.

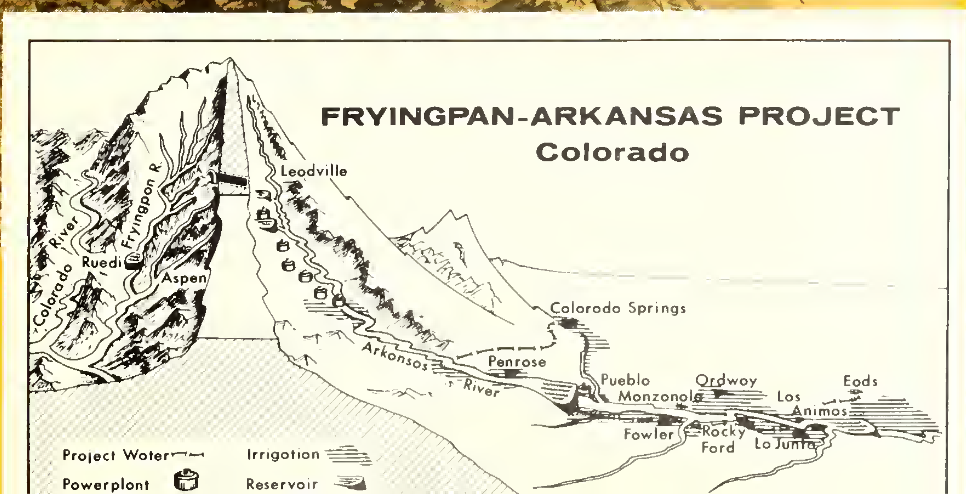
U.S. Department of the Interior
Bureau of Reclamation

RECLAMATION

ERA

May 1965





Reclamation
ERA

MAY 1965

Volume 51, No. 2

OTTIS PETERSON, Assistant to the Commissioner—Information
GORDON J. FORSYTH, Editor

COVER PHOTO. A tunnel might symbolize the Fryingpan-Arkansas Project's "great road to glory." Although the tunnel shown is not that "great" principal structure which will carry mountain water from the west to the east side of the Divide, it does illustrate the progress of construction on the project. The picture is of the project's Ruedi Dam diversion tunnel, taken on January 21 by photographer Larry Taylor. Construction on the other, the Fry-Ark Divide Tunnel, will begin this spring.

United States Department of the Interior
Stewart L. Udall, Secretary

Bureau of Reclamation, Floyd E. Dominy, Commissioner

Washington Office: United States Department of the Interior, Bureau of Reclamation, Washington, D.C., 20240.

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Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C., 20240. Use of funds for printing this publication has been approved by the Director of the Bureau of the Budget, January 31, 1961.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Price 30 cents (single copy). Subscription price: Four issues (1 year) for $1.00 ($1.50 for foreign mailing).

Colorado's New Future *with the* FRY-ARK

by ELEANOR GALE

"SOUTHERN CALIFORNIA NEEDS COLORADO RIVER WATER." It was painted blue and glittering gold, and mounted over an archway at the Los Angeles County Fair, in a pavilion which housed a marvelous display of the abundance to be found in southern California.

I walked from building to building, through lush gardens planned by experts and nurtured all year for this one "home and garden" show, viewing many varieties and mammoth examples of citrus and avocados, cars and homes of the future. And I was struck by a shocking comparison.

It was my first year in college away from home, and *this* was nothing like home! Our town had no palm trees, no orange groves; our State fair exhibits were mostly sheep and cattle, and dust. Our town was in southern Colorado. Southern Colorado, I decided, also *needs* Colorado River water!

I remembered the summer before, when we were allowed to irrigate our lawns every other day. Some people even "rustled" water after dark, for their thirsty lawns. Shower baths were limited in some places, and air coolers were outlawed. Cattle were dying and ranchers and farmers were moving out. And nobody was moving in.

Each day through the mail I received copies of my hometown paper, the *Pueblo Star Journal and Chieftain*, rolled up the size of a toothpick compared to that of the *L. A. Times*. In it I read of the needs and support for the project which would save the Arkansas Valley from its yearly classification as a disaster area. The Fryingpan-Arkansas Project had for many years been the "darling" of countless organizations throughout southeastern Colorado and certain partisan legislators in Washington.

What was this project with the unusual name? It was a multiple-purpose project which would supply supplemental water for irrigation of crops—also municipal and industrial water, generation and transmission of hydroelectric power, control of floods, provision for the preservation and propagation of fish and wildlife, and creation of new recreational opportunities in Colorado. The Fryingpan-Arkansas Project borrows its name from the Fryingpan River, a tributary of the Roaring Fork River, from which water will be diverted under the Continental Divide and into the Arkansas Valley in southeastern Colorado. It is a name which stuck, and it belonged to a project which "stuck."

For or Against

For 30 years in Colorado, the Fryingpan-Arkansas Project was something you were *for* if you lived on one side of the divide—and *against* if you

Secretary of the Department of the Interior Stewart L. Udall speaking at groundbreaking ceremonies for Ruedi Dam, July 19, 1964.

People of Leadville, Colo., a town famous for its mining history, are feeling some excitement as the project development starts. The east portal of Divide Tunnel will be 5 miles from this town.

lived on the other. For 10 years in Congress, Pennsylvania argued against it because it meant spending money on public power. California argued against it because many of its people felt it was a plan to rob them of something which by rights belonged to them. They felt that they owned the water involved. And among those in Colorado who did want it passed, many were homemakers who realized the poor quality and scarcity of the water available to them, or businessmen who knew that to survive economically, arid parts of Colorado had to have more water. But they really didn't know what was involved from a political standpoint, and certainly not from the engineering standpoint.

The western slope needed water. But I was from the eastern slope. That night at the fair in California, I decided to learn as much as I possibly could about the project, a subject which has held my interest for the past 9 years. I've read a bookshelf full of background, traveled to Washington and back, and even made myself learn to understand engineering principles and terms. I've learned Reclamation jargon and the politics involved. Now "acre-feet" is a household word, and I can recite the project's legislative history backwards.

But now the Fryingpan-Arkansas project, instead of remaining a legislative "case history," ha become a priceless part of Colorado's future. I 1962 it found its congressional approval—havin been researched, changed, and planned by th Bureau of Reclamation people enough to satisf western Colorado interests and unify Colorado i its favoring of the project. Several sets of legi lators had come and gone until the right combin tion occurred, and the bill was passed—all $1 million worth of it.

What will those millions buy? A series of dam tunnels, canals, reservoirs, powerplant—the ingr dients of a new era in Colorado.

On July 19, 1964, ground was broken for t first stage of the project, the construction of t $20-million Ruedi Dam and Reservoir, which i planned as a compensating impoundment, to st 100,000 acre-feet of water for western Colorad benefit. This initial phase of the project, whi will take about 1,300 days to complete, is the c ciding factor which brought favor to the bill i Congress and consolidated Colorado's interest i

Eleanor M. Gale

Mrs. Gale, born in and a resident of Pueblo, Colo., for 22 years, now lives in Denver with her husband Dr. Scott A. Gale and three youngsters, ages 4, 3, and 2. An aspiring writer, she recently had her first major publication—a first-person experience in the November 1964 edition of *Redbook Magazine.* Having majored in creative writing at Pomona College, Claremont, Calif., an opportunity for her to write about something in which she really believed occurred in her junior year, when she spent 6 months in Washington, D.C., studying the Fryingpan-Arkansas Project. Her voluminous writings on the project are now in the Library of Congress. Mrs. Gale combines writing and homemaking with a part-time job doing institutional research at Colorado Woman's College in Denver.

the project. It is also one of the major reasons for he rise of the estimated cost of the project since 1957. This cost includes the dam, a reservoir with 12 miles of shoreline, relocation of many miles of county roads, and buying rights-of-way. Working continued during the winter to drill a tunnel so that a cofferdam can be erected this year to divert the Fryingpan River, to allow the erection of the permanent dam to begin this spring. Ruedi Dam is expected to be completed by February of 1968.

At this beginning, the Fryingpan-Arkansas Project, called by Interior Secretary Steward L. Udall "one of the greatest water-resource developments ever undertaken in the West," has already begun to employ workmen and in other ways benefit the economy of the State. It is expected that he project will require 5,000 man-years of labor alone.

Impact of Recreation

The U.S. Forest Service has estimated that the development of recreational facilities in the White River National Forest would cost approximately $1.4 million. These facilities will include roads, trails, campgrounds, picnic sites, docks and boat landings, parking areas, tree and shrub planting and grass seeding, costs of which are nonreimbursable. The recreational impact area involves 182,700 acres, 8,800 of which are now private land. Property values have begun to rise impressively.

Of the project as a whole, money spent for irrigation, power, municipal water supply and delivery systems—over 90 percent of construction cost—will be paid back to the Government. And this, together with interest, will result in a total reimbursement of $228 million to the U.S. Treasury.

The next phase of the Fryingpan-Arkansas Project will be the development of the western slope water collection system—drawing from the south side collection area, and involving the construction of three major tunnels. One of these, the Divide Tunnel, is 5.3 miles long, and has a 10½-foot-diameter bore. It will carry water from the west to the east side of the Continental Divide, to Turquoise Lake (also called Sugar Loaf Reservoir) 5 miles southwest of Leadville, Colo. This town, famous for its mining history, has become the scene of exciting development with the beginning of the project.

About 70,000 acre-feet of water from Turquoise Lake (enlarged from 17,000 acre-feet capacity to 117,000 acre-feet capacity), will be carried annually through a series of canals to Twin Lakes Reservoir, which will be enlarged to five times its present size.

From Twin Lakes Reservoir, the water will be released through a series of powerplants into the Arkansas River near Salida. From this point, the water will flow in the river to be impounded in Pueblo Reservoir, which will be formed by the erection of Pueblo Dam across the river west of Pueblo. Pueblo Reservoir will store 400,000 acre-feet of water. This phase will involve relocation of about 20 miles of Denver and Rio Grande Railroad track, with a seventh powerplant to be located at Pueblo Dam. The new lake will have a 61-mile shoreline.

For most residents of Colorado it is impossible to realize the great changes the Fryingpan-Arkansas Project will make in the economic structure of the State, and the types of businesses which will be attracted to the area. Many of the towns in Colorado, which are now simply places to "go

This is the waterless Colorado Canal photographed in 1963. It is northwest of Ordway in the project area.

through," will become attractive recreational areas. Pueblo, my hometown, will, upon completion of the reservoir, have a high tourist potential.

Colorado, until recently, was not achieving the amount of progress which by rights it should enjoy as one of the States richest in natural resources and scenic beauty. Today, it has a reputation of being a playground for the winter sportsman and a paradise for the summer camper. But this does not give enough attention to the situation of the year-around resident of Colorado—who gives and gets all which is his within the State alone.

Colorado's Appeal

We've heard western slogans containing romantic words and emotional appeal, but we've known in the past that these could not apply to us because of our desperate lack of water. Given Colorado's space and beauty, given its strategic location as the real center of the United States, given its clear air and the ease of transportation within its boundaries, its relatively untapped labor resources and its enthusiastic, progressive businessmen—given all these valuable factors, Colorado's score would still be low without water. With water where needed, Colorado will emerge the important Western State that it could be.

With more water for irrigation, Colorado land now involved in farming will yield more varied crops to feed the growing population of the State.

With more municipal, domestic, and industria water available, new and long-term industries wil join the already established and internally well developed industries currently enjoying the ad vantage of the large amount of undeveloped lanc in the State. New cities will emerge, and well rooted cities in Colorado will grow and improve in quality—reaffirming the faith of those who have already invested in housing developments, apart ment complexes, new schools and shopping centers These were threatened with being surpluses the already burdened State could not afford to bear before the certainty of adequate water.

The Bureau of Reclamation has done its par in honestly and accurately planning and designing the most feasible project to alleviate the Arkansa Valley's lack of water; the Congress has given it approval and appropriation of funds; now it's u to Colorado to plan wisely for the many benefit which will result from the project.

The real key to the State's future development i to be found in such planning. Colorado should b able to utilize the knowledge. There are example of several areas within our United States whic have grown without careful anticipation or co ordination. But we have the years before th Fryingpan-Arkansas Project will be complet Let us now plan ideal communities.

The Fryingpan-Arkansas Project is a valuabl investment in the future of Colorado. # # #

This is the story of an Indian Engineer and his family who came to America, and whose stay has been for the greater good of both countries. Denver and the Bureau of Reclamation have accepted them and a channel has been opened for two-way traffic of friendliness and learning.

INDIA SENDS THE PATHAKS

by DOROTHY BROSE GARLINGTON
Denver, Colorado

The "spirit of helpfulness" shown by the United States to India in her vast dam-building program has been warmly praised by K. S. Pathak, technical attache for the Embassy of India, Washington, D.C.

An engineer with the Irrigation Branch of the Punjab Public Works Department prior to his U.S. assignment in March 1963, Pathak noted the friendly relationship that has existed for some 20 years between the U.S. Bureau of Reclamation and the Government of India.

Through various technical assistance agreements, India is able to benefit from the reservoir of engineering know-how and experience built up by the U.S. Bureau of Reclamation, Pathak said.

"But," he emphasized, "it is the spirit of helpfulness, the willingness, and readiness of share that far transcends merely meeting the terms of an agreement."

Pathak, who designed the powerplant for India's famous Bhakra Dam, has been serving for nearly 2 years as liaison officer between the India Supply Mission and the U.S. Bureau of Reclamation. Since much of his time is spent in the Bureau's Denver offices and laboratories, Pathak's wife, Kamla, and their four children have made Denver their "home away from home."

Although his job has various aspects, Pathak's primary concern is with the Beas Project, which involves an earth dam 400 feet high (with a powerplant and five diversion tunnels) and another 200-foot-high dam with two 8-mile-long tunnels connecting the River Beas with the River Sutlej, for power generation through a 1,000-foot drop.

"Our Indian engineers prepare the designs, serve as contractors and inspectors," he explained.

Mr. Pathak, center, checks part of a design for a future dam in India with E. E. Esmiol, left, and Fred C. Walker, Bureau engineers.

"But—as our work progresses, we can request advice and information on highly technical matters under terms of a 1951 agreement between our two countries for scientific and technical engineering services. "And never once," he noted, "have I ever asked for assistance that it wasn't granted readily.

"If I explain to Bureau officials that we are having some problems on which we need advice of their engineers, we get it. And if a firsthand consultation on the spot is needed, the Bureau expedites arrangements for the engineers to come to India. Thus we benefit from the valuable experience built up by the Bureau of Reclamation over a period of 60-some years that it has been developing and conserving water resources throughout 17 Western States," Pathak said.

Officials Visited

Many Bureau engineers and officials have visited India upon invitation, but within the past 2 years the list has included Commissioner Floyd E. Dominy, Chief Engineer B. P. Bellport, and General Physical Scientist O. L. Rice.

Having this exchange of views and firsthand experience is proving "a very good working agreement," Pathak said.

Similar views were expressed by Chief Engineer Bellport when he noted that the Bureau of Reclamation "has been happy to share our experience and knowledge with India. "K. S. Pathak," he added, "has very effectively provided the key liaison so essential to a program of this nature."

General Physical Scientist Rice praised Pathak as "a fine engineer" and said: "It has been a pleasure to work with him in support of the Beas and other water resources projects in India."

Besides the Beas Project, Pathak deals with other problems referred from India, such as the Khadakvasla Dam near Bombay which breached and has had to be repaired. Two senior Bureau engineers were sent to study and advise, he said.

Another of his responsibilities is "trying to keep my Government informed on the latest technical advances and engineering developments."

"The U.S. Bureau of Reclamation publishes results of its work for the whole world to share," he noted.

"In our case, we may not face exactly the same problem today as is being worked out here—but accumulating facts can be very useful for the future."

Another important contribution which the U.S. Bureau of Reclamation makes is sharing its testing facilities—running tests on concrete, for example, which may be similar to those being made by Indian engineers, but which will thus enable them to compare results and get a double check on safety and effectiveness.

Pathak pointed out that India also draws from private engineering consultants, some of whom have been associated with their works for many years. His position includes contacts with them, as well as with manufacturing firms since India buys some of its major construction equipment from the United States.

Pathak recalled an observation made by India's president, Dr. S. Radhakrishnan, when he was honored in June 1963, by the University of Denver and by Denver's mayor.

In a dinner speech, Dr. Radhakrishnan cited a visit he had just made to the U.S. Bureau of Reclamation's Denver laboratories where he had observed Bureau engineers testing soil brought 10,000 miles from his homeland, and he had noted, "how small is the world today when you look at such cooperation and friendship."

Friendly Arrival

Friendliness and hospitality described as "almost unbelievable" also are cited by Pathak's gracious and charming wife, Kamla, when she talks about the family's arrival in Denver.

"We first stayed in a motel near my husband's office," she recalled. "Right away a neighbor offered to take our children to school with her own, and one of my husband's colleagues drove him to work until we could get a car of our own."

"Within 2 months we found a furnished house to rent. There never was any question—the owner who was going to the University of Illinois for a year of advanced studies, just turned over the keys and told us to make ourselves at home."

The Pathak's eldest son, Pramod, 19, enrolled at the University of Colorado where he plans to get his degree; their two daughters—17-year-old Sunita and 16-year-old Archana entered Lakewood Junior High School; and 9-year-old Rajiv, the youngest son, started classes at Lakewood Elementary School.

The children's facility with English made school adjustment no problem. Rajiv, according to his teacher, is providing stimulus to his fellow students.

"Prior to the American presidential election," Mrs. Pathak commented, "the teacher called me to express amazement at Rajiv's interest in the American political system as well as in the candidates!"

Pathak said that often, when he leaves for work at 7 a.m., he finds Rajiv sitting up in bed, clipping the newspaper for articles pertaining to his studies in school.

"He's also become a baseball and football fan," his father said. "He plays those games with his friends—but he also enjoys cricket with the whole family. We got a set from India, and when we all play cricket in our backyard, we have a regular audience of neighbors," he smiled.

The girls wear American-style clothes to school, but at home and at parties they prefer Indian-style outfits of salwar, kameez, and chunni. They get frequent requests to give talks about India before various schools clubs and groups. When guests are entertained in the Pathak home, Sunita entertains with some traditional Indian dancing. In keeping with their national custom, their mother said, the girls never go to mixed parties—nor have they ever asked to do so.

Carry on Traditions

Mrs. Pathak said that the family always speaks Hindi and Punjabi among themselves, and in their family life they try to carry on other important Indian traditions. Her husband, for example, reads and prays before a little Hindu shrine each morning. She said she never wears anything but her traditional sari—except, she laughed, when she gardens or shovels snow. Then she self-consciously puts on a pair of slacks—and hastens to change before any visitors ever see her.

"We did not bring a servant with us, although we could have done so," she said. "First of all, we wanted to live as most American families do—and we felt it would be important training for our children to learn to help around the house and yard, as they are doing."

Mrs. Pathak does all of the cooking—Indian style, she said. "We can find in American stores just about everything we used in India, and the children and my husband are very helpful." She smiles as she remembers how time-consuming the preparation for their first meal for guests seemed. "But now it doesn't bother me. In fact, when I was invited to a church luncheon and discovered the ladies wanted to have Indian curry but had never had any experience with it, I volunteered to prepare curry for 138 guests—and they observed and learned."

Discussing earth samples brought from India for testing are G. E. Burnett, Chief Research Scientist; Krishan Pathak, and Harold J. Gibbs, Chief Soils Engineer.

She gets many requests to talk about India before various clubs and organizations. She also was invited to model Indian dress in an International House style show and before an organization of Bureau of Reclamation wives.

"Sometimes it requires a whole day off from my home schedule," she admits, "but I feel as though if I can in some way help the women of our two nations come closer in friendship and understanding, then it is more than worthwhile. And it is stimulating for me, too, because many of these ladies are well-informed and ask many questions," she added.

After an illustrated article about the Pathak family was published in *The Denver Post*, Mrs. Pathak said they began receiving many letters—some of them from persons desiring more information, some of them from Americans who had visited India, some of them from persons wanting first-hand contact with the Hindu religion or other aspects of Indian life.

The Pathak family belongs to the Colorado Mineral Society, with rock-hunting as a hobby. They also joined the Mount Vernon Country Club, located in the nearby mountains, which has a regular waiting list of hundreds desiring membership.

"We are very happy and very busy here in the United States," Mrs. Pathak said. "But never do we forget that India is our homeland—and that we want to do everything we can in every way possible to help further our country's progress." # # #

RECLAMATION STRUCTURES

Curtail Pacific Coast Flooding

Reclamation's multipurpose dams in northern California, Oregon, Idaho, Washington, and Nevada figured importantly in curtailing the devastating floods that struck Pacific coast areas during the 1964 Christmas season. Some of the same stricken areas were beset again by the relentless waters during the first few weeks of the new year.

Excessive precipitation increased storage behind four dams—Shasta, Trinity, Whiskeytown and Folsom—on the Central Valley Project in California, gaining a total of 1,570,000 acre-feet during late December. Meanwhile, Reclamation-operated dams and reservoirs did yeoman service in passing flood crests safely through the Sacramento Valley, with particular credit going to Shasta and Folsom Dams.

The operations at Shasta Dam were crucial throughout the threatening period. It caught and held 800,000 acre-feet of flood runoff in the Sacramento River and was credited with saving $40 million in damages.

A saving of $45 million in damages is credited to Folsom Dam, as it completely eliminated downstream flooding. Behind this dam, Folsom Reservoir received an inflow of 822 percent above the December normal.

The prevention of damage by other California dams—Monticello, East Park and Stony Gorge—is known to be substantial.

Approximately $210,000 damages were sustained at the Nimbus Fish Hatchery, where the fish ladder leading from the American River to the hatchery was largely swept away in the flood. This facility, constructed and owned by Reclamation, is operated by the California Department of Fish and Game. Reclamation is making a new detailed study of how the lower part of the ladder might be redesigned to prevent similar damage in the future. All renovations are to be completed by the end of next summer, in time for the salmon run.

Canal Bank Torn

Damages to Corning Canal, on the Central Valley Project, are estimated at $55,000. Several hundred feet of the canal bank were torn out during the flood by overflow from Thomes Creek, an uncontrolled tributary of the Sacramento River.

The severity of the floods resulted in several locations being designated by President Johnson as disaster areas, with the cost of temporary repairs to be borne by the Federal Government.

Hoopa Valley, an example of a disaster area, suffered damages estimated at more than $2 million during Christmas week when Trinity River overflowed just south of its juncture with the swollen Klamath River. Most of this valley remained underwater for an extensive time because of the overflow from normally small creeks feeding into the Trinity. The creeks carried debris, mud, and shale into the area, clogged the channel and ran free over the farmland.

The Office of Emergency Planning has designated the Bureau as its agency in charge of rehabilitation of the severely flood-damaged Hoopa Valley.

When this issue of the *Reclamation Era* was sent to the printer, winter weather had prevented detailed estimates of damages in some areas resulting from the December and January flooding. However, in the three Northern States, total estimated damages both to areas where the Federal Government had performed construction or rehabilitation work, and where it had not, was Oregon, $827,300; Idaho, $168,200; and Washington, $120,500.

Dominy and Committee Inspect

Reclamation Commissioner Floyd E. Dominy joined the Special Subcommittee of the House Public Works Committee during the week of January 11, to inspect the destruction as it related to the Bureau in California and Oregon. The review, both from the air and on the ground, included detailed observations as well as discussions of corrective measures to be handled by Reclamation.

After making the personal inspection, the subcommittee reported to Congress on January 26, that the total damages will exceed $1 billion, particularly when lost jobs and employment opportunities are taken into effect. The death toll as of February 8, was 23 persons.

In Oregon, Prineville Dam completely controlled the highest flood of record on the Crooked River, preventing damages that would have exceeded the entire cost of the dam and the rest of the Crooked River Project.

Lucky Peak Dam and Reclamation's Anderson Ranch and Arrowrock Dams on the Boise Project in Idaho, contained a peak inflow of the Boise River of 34,000 cubic feet per second—the highest in 69 years. These dams limited the river's outflow to 150 cubic feet per second, preventing estimated flood damages of $12–$13 million.

Cascade Dam and Deadwood Dam on the project's section of the Payette River near Emmett, prevented estimated flood damages in excess of $3 million.

All Reclamation flood-control structures in the Columbia River Basin in Oregon and Washington weathered the storm without damage. A serious ice jam on the Yakima River in Washington forced Roza and Chandler powerplants to go off the line.

Storage in reservoirs throughout Oregon including Emigrant, Ochoco, and Prineville Reservoirs were filled, or very nearly filled. However, prompt, but controlled drawdowns there and elsewhere gave assurance of adequate storage space for controlling any further floods that might develop.

Also, storage in Lake Roosevelt behind Grand Coulee Dam, as well as in most other reservoirs in the Pacific Northwest and California, is well above normal. Irrigation water supplies for this growing season range from good to excellent.

On irrigation structures in different parts of the flood-damaged area, where rehabilitation and repairs were made necessary, rockwork and such repairs not affected by adverse weather, were started as soon as working conditions permitted.

# # #

Sandbagging and dredges from the San Francisco Bay area were put to use by hard-working emergency crews to strengthen levees weakened by storm waters and high tides in California.

Though the swollen American River did not reach the caved-in area shown here, the forceful waters undermined such permanent structures as the concrete steps on the Folsom Unit.

Was It From Work, Irrigation, Or The Gleam In John's Eye?

CROPS ARE COAXED FROM A SAND PILE

by ERNEST DOUGLAS, Editor, Arizona Farmer-Ranchman

In telling the heart-warming story of the Curries, first emphasis could be placed on the citrus boom they started inadvertently and made their \$300-an-acre land worth \$900 to \$1,000. It could be on the 40 acres that Jack recklessly bought for a song because he needed a longer runway for his airplane, and 4 years later he was offered \$40,000 for it. But the real story, the big story, is how he made a productive farm out of soil that was hardly more than blow sand, getting yields of cotton and alfalfa comparable to those of neighbors fortunate enough to have some of the richest loam that lies out of doors.

In 1954 John A. and Joy Currie and two small daughters settled on what was formally known as the Mesa Development Farm, but other residents of the Wellton-Mohawk Project came to know as "Currie's sandpile." Soon they're moving off, not because they haven't come to love the place they once almost hated but because most of their land has been sold for citrus development at several times its value for field-crop production.

Strangely, it was the Curries who demonstrated that Wellton Mesa is ideally suited for grapefruit, oranges, and lemons. They reluctantly irrigated but otherwise neglected 100 trees planted around their home by the Bureau of Reclamation, and all but the lime trees flourished.

"That was the one thing the Bureau asked me to do that I didn't want to do," Jack admits. "And it was the experiment that paid off biggest."

Delivery of Colorado River water to the Wellton-Mohawk District, through an all-concrete system built by the Reclamation Bureau, began in 1952. About 14,000 of the project's 75,000 acres are on Wellton Mesa, above Mohawk Valley, and their soils are radically different. In their natural state Mesa soils are sandy, with little organic matter or water-holding capacity. Settlers trying to make them produce were meeting problems. So were farmers on Yuma Mesa, 40 miles west, where conditions were similar.

So the Mesa Development Farm was laid out by the Bureau, 7½ miles northeast of the town of Wellton and almost at the edge of the bluff that separates mesa from valley. It was 200 gross acres but only 157.5 were rated irrigable and roads and ditches reduced actual crop acres to 146. The soil was classed as No. 2 and No. 3.

The objectives have been set forth at length in a complete report compiled by Robert Moody at the Bureau's Lower Colorado office in Yuma, Ariz. First and foremost, could profitable crops be coaxed out of such unpromising earth? If so, how should it be irrigated, fertilized, and generally managed? What crops were best adapted?

The Bureau got answers to all these questions and more. It began getting answers, useful to all farm operators on the two mesas, almost as soon as the Curries arrived. But it's doubtful if such a wealth of reliable information could have been gleaned had the lessee been anyone without the training, temperament, and tenacity of Jack Currie, backed by a wife of Joy Currie's courage.

They're an irrigatin' family, the Curries. From left are Cindy, Joy, Jack, Diane and Sharon. Diane, now 6 and born right there on the Development Farm, thinks she's big enough to take over the citrus irrigation chore from her mother.

Jack was an Arizona farm boy who grew up in Salt River Valley, and a World War II veteran. In service he had met and married a Tennessee small-town girl who had a good idea of what farm life was like there but no idea of what it would one day be like on Wellton Mesa. By 1954 he had graduated from the University of Arizona College of Agriculture and spent over 3 years conducting irrigation studies for Oregon State College at Madras, Oreg. That's where he learned to keep the records that made him such a valuable cooperator with the Bureau of Reclamation.

Winning Applicant

There were half a dozen applicants for the Development Farm lease but no other had the qualifications of long, lean, earnest Jack Currie. "The hardest part in winning the contract was to prove that we could raise $6,000 if we absolutely had to," Mrs. Currie recalls. "We even had to count in the cash surrender value of insurance policies."

So they moved into the little cottage built by the Bureau on the "farm" that had been ditched and leveled. Except for some experimental ditch lining, and those citrus trees, no other improvements were added by the Bureau.

"We knew about the sand but nobody told us about the sandstorms," Joy says. "Ugh! They made life miserable for us every little while, until Jack sort of got the sand tied down with alfalfa."

Most vivid of their memories is of the "big blow" that almost blew the Curries back to Oregon. All through the day a high wind raised dust clouds that restricted visibility to a few feet. Despite every precaution, sand sifted into the house and rippled across the floor. Joy and Sharon, then 7, swept madly while Jack stuck to his work outside, reasoning that he would be no better off indoors. Only family member who seemed to be having a good time was Cindy, who slept and gurgled in her crib.

When Jack came in from his farm work, black and grimy and eager for a hot shower, Joy met him with more bad news. The sand had got into the pump that pumped water from the nearby canal, through a filter system, to their bathroom and kitchen. No water!

"He didn't say a word but just flopped into bed, dirty clothes and all, and pulled a sheet over his head," Joy relates.

But the next morning the wind had died away and a calm world was bathed in bright sunlight. Jack desanded the pump and the Curries had water again. They stayed.

Grass around the house would, of course, reduce the sand nuisance, but getting Bermuda established was something else again. It was impossible to keep the ground surface damp enough

Reclamation and cooperating agencies sponsored a Field Day at the Development Farm a few years ago. Jack Currie was the principal performer at the microphone. (Photos by E. Douglas)

that stiff breezes didn't blow the grass seeds right out of the sand. So Bermuda sprigs were begged from valley friends, and planted. Soon every sprig was on a little mound, the sand around it blown away. Joy replaced the sand again and again, watered it down, struggled on until she had a lawn.

All this time Jack was having trouble with alfalfa seed. It was blown out of the ground, too. He bought used target cloth from military surplus, scrounged old railroad ties, and improvised temporary windbreaks around his fields. They gave enough protection that the alfalfa seeds could germinate and the seedlings could grow anchor roots.

Alfalfa helped to make soil out of sand—that and crop residue, for every cotton stalk and weed got turned under to add humus and plant nutrients and retain moisture. Minutely planned irrigation and fertilization, in line with results and also with common sense as well as Jack Currie's training and experience, led from an uncertain beginning to ultimate success.

"It all worked out as I hoped it would but wasn't a bit sure it would," he says.

His yields were above State averages, seldom far behind those of neighbors on better lands and often higher. In 1961, for instance, his average on 18.2 acres of short-staple cotton was 1,263 pounds of lint; on 33.2 acres of long-staple, 763 pounds. Right along, on alfalfa cut for hay throughout the year, he has averaged 6 to 6.5 tons—and nearly always got premium prices because of superior quality. In 1962 he grew safflower on 46 acres, got a yield of a ton and a third, grossed $100 a acre, and dropped that oilseed crop only because of an uncertain market.

Livestock, Too

Currie is a livestock farmer, too. In 1959 he started a Brangus herd that now includes 27 mother cows and a registered bull owned in partnership with another farmer. The cattle have done more than well, entirely on broken bales and summer hay and on forage that would otherwise be wasted. He has raised sudan grass for pasture; cotton stubble is pastured off before plowing under. The calves gain as much as 2.5 pounds a day through their first 7 months, a rate that any breeder might envy.

It must appear to the outsider that Jack Currie achieved triumph under several severe handicaps in addition to those imposed by nature. He started with almost no ready cash, so what about financing?

"No problem at all," he grins. "The Farmers Home Administration saw us through, until the county advisory committee decided that I could get credit elsewhere. Then I was put on the committee and that made me doubly ineligible."

So he took his account sheets to a bank, and that banker had never seen a set of farm records so complete. They showed what he had done every day since his arrival, almost what had been done every hour. How much water had been applied, as metered by devices the Bureau had installed, and when. Plowing, leveling, cultivation, harvesting, costs, sales—everthing. Every cent he had borrowed and repaid was there.

No. Finance wasn't any obstacle. Oh, the bank may have hesitated in 1959 when he and Joy decided to exercise their option and buy the farm at appraised value for field crops; but again Jack convinced the directors that he was a sound risk and they went along.

The lease from the Bureau did lay down very rigid requirements as to records, but still the Bureau got far more details than anyone expected. "When he comes in for lunch he won't eat a bite until he sets down all he did that morning," Joy testifies. "In the evening he'll spend hours with those books."

"If every farmer kept full records, so as always to know just where he stands, there wouldn't be enough farm failures to mention above a whisper," Jack comments.

The Development Farm project was organized with advice from the University of Arizona, Agricultural Extension Service, U.S. Agricultural Research Service and Soil Conservation Service. Annually, representatives of those agencies, the FHA, and, of course, the Bureau, met with Mr. Currie to go over his narrative of the year and help him plan for the future.

"Having to explain things to those fellows was no handicap," he states. "Really, it helped to keep me on my toes, and I got many a good idea from them. They didn't insist on my making one move I didn't want to make."

Close relations have been maintained with the Bureau, although the main experiments were concluded in 1958 and the Development Farm program was formally terminated at the end of 1962.

The main general conclusion is that, yes, a profitable family farm enterprise can be conducted on the thin soils of Wellton Mesa. The land should be precisely leveled. Water should be applied frequently in large heads, to get through quickly and allow minimum time for percolation below the root zone. Phosphate fertilization is essential.

One of the extra experiments that Currie carried on, and gladly, was in low-cost ditch lining. The Bureau lined some of his ditches with various materials and he helped to keep records, also made observations that aided the technicians in reaching valid conclusions. But he wanted no part of the citrus experiment.

Yuma Mesa had proved ideal for citrus groves, so why not Wellton Mesa too? Many eyes were turning in that direction but general opinion was that winter temperatures were too low. So the Reclamation Bureau planned a conclusive test—at the Development Farm.

Jack Currie is justifiably proud of his Brangus cattle. His may be the most profitable farm herd in Arizona, since it gets along almost entirely on waste feed.

Varieties of Citrus

From 1955 to 1957, 100 trees of 16 varieties were set out around the Currie dwelling. The family head had no time to spare from his cotton and alfalfa, so the irrigation chore fell on Joy. Those trees got no further attention, not even a shovelful of barnyard fertilizer. But 97 are alive today, all but three limes that proved too tender for even mildly chilly nights. The survivors are in vigorous health and bearing abundantly.

This demonstration converted the skeptics and touched off a veritable boom. Today Wellton Mesa is dotted with pretty young orange groves and predictions are heard that all its irrigable acres will be in citrus within 3 or 4 years.

Inevitably the boom involved its point of origin. One 1964 day a developer came along and paid the Curries $64,000 cash for 80 of their Development Farm acres. The new owner promptly put the 80 into citrus and just as promptly sold the tract to investors in 10-acre blocks. Another buyer paid the same per-acre price for a 50 and in the winter of 1965 was releveling it for citrus.

This left the Curries with few cultivable acres out of the original farm, but a 40 at the southwest corner. There's quite a story connected with that 16th of a section.

Once a flyer always a flyer, and in military service Jack had been trained as a pilot. In 1958 he achieved a long-time ambition and acquired a Cessna. But the longest road on the place wasn't quite long enough for a safe takeoff. An adjoining 40 of undeveloped, unleveled sand was for sale at $7,500. He didn't have the money, didn't want to do any more sand reclaiming, but he did want most terribly to make use of that plane.

So the tract was bought and 10 acres added to the Currie runway. The others were seeded to alfalfa under a sprinkler system that he bought secondhand, as he bought most of the farm equipment he used in the early years. Hay sales have more than repaid the cost of developing and planting the 30.

The other day a realtor came by and said he had a purchaser for the whole 40, at $40,000 cash. Now the Curries can't decide whether to accept that offer or another, at a comparable price, for the remainder of the Development Farm. For Jack has caught the citrus fever, too; he means to have an orchard of his own, on one block or the other.

Anyway, the family looks forward to early occupancy of a new home 4 miles away, on the lip of the bluff and overlooking 240 acres of Mohawk Valley's most fertile loam. It was once two farms, bought and combined by the Curries right after those 1964 citrus-land sales.

"If I can almost raise three-bale cotton up here I can raise four bales down there," says Jack Currie with a faraway gleam in his eye. "Maybe five."

# # #

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Bureau Hosts Fourth Annual
IRRIGATION OPERATORS' WORKSHOP

The Bureau of Reclamation's fourth annual Irrigation Operators' Workshop held in Denver, Colo., starting on November 16, 1964, drew 116 participants representing all of the 17 Western Reclamation States, 7 universities, and including 9 visitors from foreign countries.

From a varied and extensive program, the *Reclamation Era* has chosen to report on one of the courses which was an inviting and practical approach to the efficient use of water for irrigation.

The article, entitled: "Bettering Your Management of Water," is the author's own slightly shortened version of the paper, "Water Management Facilities."

Mr. Nelson is Chief of the Irrigation Operations Branch at Reclamation's Region 1 headquarters at Boise, Idaho.

Bettering your management of WATER

by THEODORE NELSON

With the growing need for water, it is becoming more apparent that some of us have developed bad habits in water usage. I have seen water users deliberately overirrigate in an attempt to establish a high-use record to insure their future rights, and we have all seen water wasted where the irrigator has used water to conserve labor.

Similarly, project operators have, in many instances, carried excessive quantities through their system, wasting substantial portions simply for operating convenience. Other unnecessary waste is the refusal on the part of water users to irrigate at night or over weekends. Most of this waste can be stopped if we recognize the value of water and that it can be controlled, measured, and distributed equitably with proper management.

Management's responsibility to a successful project can be summarized under three simple objectives:

1. to deliver adequate amounts of water;
2. to deliver at the time needed; and
3. to deliver at a cost water users can afford.

The elements necessary to meet the objectives are: (1) adequate storage, carriage, and distribution facilities; (2) qualified personnel; and (3) equipment.

After a project has been planned and constructed, it may seem that the operator has a fixed set of facilities to carry out his responsibilities to the water users. This is substantially true. However, the adequacy and maximum value of any set of facilities is largely dependent upon how they are used. Often minor modifications, additions, or adjustments can greatly enhance their value. If a given set of facilities is not used properly nor given adequate maintenance, they will fall far short of providing the service and life intended. Thus, it becomes apparent that once a project is built, the important factor in its successful operation is the view-

point and attitude of the people who operate it.

To better understand the factors of successful operation, I would like to go on with this simplification of the elements of water management and divide them under two headings: (1) facilities; and (2) personnel. Or simpler still, let us think of them as the tools and the people.

To illustrate, it is best to talk about a specific typical storage and distribution system, to discuss the channels, the control structures, and the procedures that are being used to operate this system rather than to use a hypothetical illustration. Because of its unique operation, I have selected the North Unit of the Deschutes Project, as the framework around which to discuss the use of basic facilities and the importance of sound management practices.

A Typical Project

The Deschutes Project was completed in 1949 and is situated east of the Cascade Mountains in Jefferson County in central Oregon. It provides a full supply of water for 50,000 acres of irrigable land. The average annual rainfall is 8.9 inches; the average growing season is about 130 days. The major crops are grain, alfalfa, grass seed, potatoes, and peppermint.

Water is stored in the Wickiup Reservoir located on the Deschutes River some 90 miles south of project lands. Natural riverflow provides approximately 25 to 30 percent of the project's water supply. All water for the North Unit is diverted from the Deschutes River at the town of Bend into a 65-mile-long main canal. The lateral network necessary for delivery of water to all the lands totals 235 miles and begins at about mile 31. Average farm unit sizes are in the range of 110 acres.

General Plans of Operation

The project is operated on a modified-demand system. This means that each landowner can draw his allotted portion of water from the beginning to the end of the irrigation season or that he can order his water in any quantity permitted by his share of the system's delivery ability.

During that period of the irrigation season when the demand for water is greater than the

Checkboards are pulled from a check structure to maintain a constant water surface elevation in a major Deschutes lateral.

To help eliminate waste, this ditch rider on the Deschutes Project, Oreg., makes an entry in his water delivery record book—an important part of good water management.

system can carry, deliveries are made in proportion to the assessed acreage of each user in relation to the carrying ability of the system. Experience has proved that the per-acre peaking ability is 0.018 cubic foot per second, or 1.44 cubic feet per second, for each 80 irrigable acres.

Because of a limited supply in recent years, each user's supply has been handled on a bank-account basis. He has so many acre-feet of water in the reservoir; he can draw it out as he chooses, governed by the ability of the system to deliver the quantities ordered, but when he has drawn his prorated amount, his irrigation is over for the season.

Reservoir to Farm

In the early years of operation of the North Unit distribution system, water was wasted because of the difficulty of assuring an adequate supply at the head of the main canal to meet varying weather conditions and crop needs. It took approximately 5 days to move water from the reservoir to the last delivery on the project. This involved 60 miles of river channel and 65 miles of main canal. In 1956, the Haystack Dam and Reservoir was built, substantially relieving this situation. This is a small regulating reservoir, located at about mile 43 on the upper side of the main canal adjacent to a major drop structure.

Now water can be delivered to nearly all of the project on the basis of 24 hours' notice and substantial quantities are saved which were formerly lost in regulating river and canal flows. I think this is one of the best examples of a water-saving structure in the Northwest. I recommend you investigate a possibility for re-regulation on your system, if you have not already done so.

Dispatching

Careful and accurate dispatching is absolutely essential to good water management. This means that ditchrider orders must be assembled late in the afternoon of the operating day, and their needs summarized to determine if additional water is needed from the reserovir or if the release should be reduced. On the Deschutes Project, all orders must be in by 4:30 p.m., and the reservoir superintendent is contacted for required regulations by 5 p.m.

The importance of knowing the quantity of water in various segments of a distribution system at all times cannot be overstressed. Can you visualize safe railroad operations without knowing where all of the trains on a certain system are, and their schedules? Good water management requires the same consideration and knowledge.

An essential part of good water dispatching is a dispatch sheet. This should show daily gage readings and quantities at canal heading and diversion points, critical intermediate points along the main distribution system, and the daily requirements of each ditchrider. It is a help to the dispatcher and to the manager if the daily information from each ditchrider includes the quantity of water he drew from the system, the amount he delivered to the users, and a plus or minus on his order for the next day or 2 days if a 48-hour notice is required. Accuracy and dependability in a ditchrider are absolutely essential. He must realize there can be no compromise and that he is expected to take out of the system exactly what he ordered—no more, no less.

To Facilitate Management

As labor has become more costly and water more valuable, operators have learned that there are

many things they can do to conserve water and to reduce labor requirements. The "Little Man" automatic regulator on check and headgate structures is an outstanding example on the Deschutes Project. These float- or probe-operated, electrical time switch dampened devices control a motor-operated gate so fluctuations of the water surface of 0.05 of a foot up or down are the maximum. With this control, a rise or drop moves through the canal rapidly, the change being by displacement rather than by actual water travel. This conserves water by overcoming increased diversions because of a buildup in head which occurs before the rider gets there, when a check is dependent upon manual regulation. It also saves water through the saving of time involved in moving water through the main stem of the system.

From my observations of control structures on various irrigation distribution systems in the Northwest, I feel there are many projects that could make greater use of this type of regulating device. The advantages are not only the savings made in water but also savings made in manpower.

Another device that has proved to be a worthwhile timesaver on some of our projects has been electrically operated, automatic weed and trash refined degree, such as the weed racks in front of pumps, siphons, and facilities supplying sprinkler systems.

There are numerous other devices for which the need comes to light after the operation of a system has begun and which cannot be determined during the construction period. Some of these are special wells to facilitate closer reading of water-surface elevation, particularly where turbulence and high velocities interfere with accurate readings, floating devices to dampen water surges, floats to overcome vortexs in front of headgates and other additions that will save time and insure steady and dependable flow of water. In addition to those features that may be helpful in the ctual handling of water, we must not overlook he timesaving value of such items as cattle guards, ood operating roads, radios, dependable vehicles, tc.

Water management is an important part of roject management. We cannot appreciably inuence the price of materials or equipment and an exercise only cautionary control on wages; herefore, our value to the project rests on our ability to make the most of the opportunities as they arise to achieve better distribution and use of the water we have and to do this with the minimum use of labor compatible to adequate service.

Canal Check Structures

Check structures in the canal system are often misused. It is not unusual for a ditchrider to overlook the necessity for pulling stoplogs as the water is being raised in the forepart of the irrigation season and for replacing these stoplogs as the water goes down late in the season. It is necessary to have a certain water-surface elevation in the canal to maintain steady flows through headgates. However, if an excessive water-surface elevation is maintained, this means unnecessary loss because of additional seepage, and it also tends to encourage waterweed growth and subjects the bank to greater loads than are necessary. When a ditchrider is observant, it is not difficult to remove boards as necessary and to replace them when required.

Regulation of Lateral Headings

This item of operation goes hand in hand with the regulation of check structures. It is necessary to maintain a water-surface elevation in a supply ditch to provide sufficient head to insure steady outflows through the various lateral headings. However, if this water-surface elevation is higher than necessary, the movement of water is hampered and excessive loss and waste occur. It is the ditchrider's duty to closely regulate and measure the changes of flow in his lateral headings from day to day so they correspond with the orders that he has requested. With careful handling of

Radio is a useful management tool for informing the reservoir superintendent of the total water releases needed in the irrigation system of the Deschutes project.

all diversions from the main stem of a system, water can be dispatched and managed with a low percent of waste.

Measurement in Distribution System

Current meter stations or measuring structures at strategic locations in the main stem of a distribution system can appreciably facilitate the management of water. With definite knowledge of the quantity of water at strategic locations, the dispatcher and the ditchrider are better able to make downstream regulations without waste.

Day-by-day records of the quantity of water at major diversions are necessary to maintain adequate flow to meet all requirements. Records of the effects of previous changes provide a guide to close regulation that will eliminate unnecessary waste.

Farm Measuring Devices

I believe we all agree that, to be successful, a farm-measuring device should be simple, one that the water user understands and one that requires a minimum of time to obtain an accurate reading. When there is adequate loss of head, I prefer the baffled-weir measuring box. The reason for my preference is its simplicity, the speed with which it permits headgate regulation and the accurate readings that result. Where there is a minimum of variation between the water-surface elevation in the supply ditch and the land to be served, several operators in region 1 have found that a front end submerged rectangular orifice works very well. There are other devices that undoubtedly work equally well such as the Pend-vane, the constant-head orifice, and the Parshall flume.

Most of the farm deliveries on the Deschutes Projects are measured over Cippoletti weirs.

Equitable and Steady Deliveries

The secret of good relations with the water user depends first upon his realization that he is getting his proportionate share of the overall project supply, and second, that his flow of water is steady and dependable. The use of such control facilities on the farm as siphon tubes, gated pipes, and sprinklers has increased the importance of uniform flows. A good irrigator wants the proper amount of water to make the best use of his facilities—no more, no less.

In summary, good water management is the delivery of an adequate amount of water to the user when it is needed at a cost that he can afford to pay. As operators, I feel that we must all keep in mind there is only one purpose for our being on the job and that is to serve the water user. To do this efficiently, we must understand his needs and we must be careful so that we don't find ourselves doing for one what we cannot do for another. We must be able to disagree agreeably and to keep in mind that structure performance is not going to be any better than the people who operate them. We must be constantly searching for ways and means to improve our facilities and procedures and to be willing to make the changes necessary to keep abreast of a fast-moving world. # # #

A Poison Weed Warning

This is the time of year to be careful of the very poisonous weed—water hemlock—which likes the wet conditions along irrigation ditches. Keep children and livestock away from the plants and get rid of all you find. The root and lower portion of the hollow stem are the most poisonous. The plant has white flowers arranged in an umbrella shape characteristic of the parsnip family.

Improve Your

SALTY SOILS

by J. O. REUSS, Assistant in Soils, Montana Agricultural Experiment Station
and R. E. CAMPBELL, former Soil Scientist, Agricultural Research Service, USDA

Research for this information was done on the Bureau's Huntley Project land, cooperatively by Montana State College, Bozeman; the Agricultural Research Service, and the Bureau of Reclamation. It is reprinted from Montana State College folder No. 72, March 1961, by agreement with Torlief S. Aasheim, Director of Extension Service at the college.

A large portion of our irrigated and irrigable land is producing much less than it could because of too much salt. Research done near Worden, Mont., demonstrated that the salt can be removed and the land made productive again.

Those who did the research are soil scientists of the Agricultural Research Service and the Montana Agricultural Experiment Station. The research was partially supported by the Bureau of Reclamation.

From this research, the soil scientists have the following recommendations for getting salty or alkali land back into production:

Determine Nature of Problem

Your problem soil will fall into one of these three classes:

1. Saline—contains damaging amounts of soluble salts.
2. Saline-sodic (alkali)—contains damaging amounts of soluble salts and a rather high sodium content.
3. Nonsaline-sodic—does not have damaging amounts of soluble salts but does have enough sodium to be troublesome.

Saline and saline-sodic soils frequently have a white, salty crust when dry. Nonsaline-sodic soils usually take water very slowly and are very hard and cloddy when dry. These observations merely indicate that the soil is salty or sodic and that a problem exists.

Therefore, the most accurate way of finding out how much salt your soil contains is to have it analyzed. Then you will know the seriousness of your problem and how to solve it.

You need carefully taken soil samples to get an accurate analysis. Take samples from severely affected areas separate from those less affected. Never mix a sample from one area with a sample from a less serious problem area.

Also, take a surface sample (0 to 8 inches) and a deeper sample (8 to 20 inches) from each location. Your county agent can give you additional information. He also will instruct you on sending your samples to the Soil Testing Laboratory at Montana State College.

When salt is believed present, request a general analysis and an exchangeable sodium percentage test on the samples. The recommendations returned to you with the results of the analyses will help you plan a sound program of reclamation.

Provide Good Drainage

Most salinity problems are caused by poor drainage, either at present or in the past. Good drainage is absolutely necessary to reclaim salty land.

The drainage method to use depends upon the movement of the ground water. In some fields, you must have tile drains or ditches deep enough so the water will drain away and not come to the soil surface. Or if the problem is caused by

Thin, spotty crops are typical of salty soil.

water moving in from higher elevations, a drainage ditch or tile drain can be placed above the problem area to intercept the water.

Remember though that the ditches or tile must be deep enough so the water doesn't come to the surface. You probably will need engineering assistance for this and your local soil conservation technician may be able to help you. Also cost sharing benefits are usually available to help defray drainage expenses.

Apply Water Heavily

Where there is good drainage, irrigation water seeps down through the soil and washes salt away through the ditches, tile or natural underground drainage. Heavy irrigations, with proper drainage will wash away salt. This process is called leaching.

There are two methods of leaching. If the soil is not too salty, plant crops that will produce in spite of the salt. Irrigate these crops heavily. The advantage of this method is that it costs very little relative to other techniques.

A faster but more expensive method is to pond the water on the soil for a season or more. The land would have to be leveled. Also dikes would have to be built to hold the water on the land.

If the land is quite flat, build large dikes around the entire area. If there is too much slope for this method, build contour dikes 100 to 300 feet apart, or at about a 6-inch contour interval.

Build the dikes with a slope of 3 to 1 on the upper or deep-water side and a slope of 2 to 1 on the lower side. Have the top at least 2 feet wide. Each dike must be at least a foot higher than is necessary to back the water to the next dike above it. All the ground area between the dikes should be covered with at least 3 inches of water. So build the dikes close enough to each other to do this and still not have much over 1 foot of water depth on the upper side of the dike.

The dikes must be well built to stand erosion from wave action. By seeding the dikes with barley the damage of wave action on the dikes will be reduced. Install gates or boxes to let the water run from one dike to the next to prevent dikes from being washed out.

Here again engineering assistance will assure the proper layout for such a system of dikes.

How long to flood will depend upon the permeability of the soil and the amount of salt. Two to three months is enough for sandy soils and 5 to 7 for clay soils.

Don't take out the dikes as soon as you think the leaching is complete. Leave them in until you are sure the soil is free of harmful amounts of salt. You can raise hay or grain crops while the dikes are in place. The advantage of leaving

Same area as shown in the adjoining photo raises good crops afterleaching.

dikes in place is that you can flood again after the crops are removed.

But remember that leaching will be successful only where the drainage is good. The salts will not return to adequately leached soils provided good irrigation practices are followed.

Use of Chemicals

There are a number of chemicals which are used effectively on sodic soils. They are called amendments. Most of them replace harmful sodium with calcium. They are used to correct a sodic problem which may occur on either saline or nonsaline soils.

However, amendments cannot neutralize excessive soluble salts, so leaching is required to be certain the salts are taken from the saline-sodic soils. If the leaching water contains calcium or the soil has free gypsum, amendments are not necessary.

Nonsaline-sodic soils often can be improved by use of an amendment plus heavy irrigation.

SOME COMMON AMENDMENTS

Gypsum—2 to 10 tons per acre.

Sulfur—0.4 to 2 tons per acre. (Requires presence of lime to be effective.)

Sulfuric acid—0.2 to 1 ton per acre. (Requires presence of lime to be effective.)

Sugarbeet waste lime, ferric sulfate, and aluminum sulfate also can be used as amendments. The soil analysis results will be useful in planning the kind and amounts of amendment to use. Expert advice should be obtained before using amendments on a large scale.

The reason many crops cannot be grown on salty soils is that salts prevent plants from taking the water they normally get from the soil. Sugarbeets, for instance, will grow on quite salty soil, but it is hard to get a good stand because

(*Continued on page 55*)

On the Redfield Farm, South Dakota

DYE DODGES DRY SPELLS

by F. ELMER FOUTZ, Chief, Land Use and Settlement Branch, Huron, South Dakota

One hundred and twenty-eight bushels of corn per acre, 135 bushels of sorghum grain and 700 pounds of beef per acre—that is what the Redfield Development Farm produced in 1963. The farm is a 190-acre unit located about 6 miles east of Redfield, in Spink County, S. Dak. It was established in 1948 by the Bureau of Reclamation, in cooperation with the South Dakota State University to demonstrate what irrigation will do for the area before the half-million-acre Missouri-Oahe Unit of the Missouri Basin Project is developed.

In 1961, an agreement was worked out with the State university to operate the farm as an irrigation research substation with all of the crop production used to feed livestock instead of being sold. Lloyd Dye, a man with a high school education and good farming experience, was selected to operate the farm.

Cropping plans and rotations were adjusted to provide the necessary feed for livestock. A small portion of the farm was reserved for production of newly introduced or experimental crops, fertility and soil management, drainage, and other research. Rather than plant only varieties of proven high yield, some experimentation with new varieties of crops is also conducted.

In feeding the cattle, an experiment using different rations and amounts of feeds was carried on, with some animals receiving less feed than was needed for maximum gains. Mr. Dye has been able to produce impressive gains per animal and even more impressive pounds of beef produced per acre, though this is a research operation. Lloyd is a crusader for irrigation in the area and he maintains that anyone on an irrigated unit could do what he has done, and probably do better, if research were not a part of the operation.

At least one formal tour of the farm is held each year, usually in the middle of the summer before the crops are harvested.

Water From the James

The Redfield Development Farm receives its water supply from the James River, pumped through 2,600 feet of 12-inch pipe. From the end of the pipeline, water flows by gravity to the rest of the irrigated fields on the farm. Because of uneven topography, 36 acres were never developed for irrigation but are dry-cropped. These fields contrast highly in crop yields as compared to the irrigated fields.

LeRoy Wenz carefully weighs feed as part of the cattle feeding experiments on the Redfield Development Farm. Mr. Wenz lives on the farm the year around.

An annual planning conference is held each year with representatives from the Bureau of Reclamation and the State university. At these sessions actual operations on the farm are planned, including cropping plans and a livestock feeding program. As far as possible, the farm is operated as an independent unit, free from interference from technicians and others. With so many activities being carried on all the time, the place is a literal glass house, open for all to see at any time. It is no wonder that Mr. Dye keeps the coffee hot most of the time. Many little problems have been solved over a cup of coffee, and big ones have been avoided.

The Redfield Development Farm is owned by Roy and William Deiter, formerly of Redfield, and now of Compton, Calif., and Silver City, N. Mex., respectively. They lease the farm to the Bureau of Reclamation and maintain the buildings and improvements, which are kept in good repair because they realize it is a show place. The Bureau subleases the farm to the State university.

Dr. Orville G. Bentley, director of the South Dakota Experiment Station and dean of the

School of Agriculture at South Dakota State University at Brookings, is technically and administratively responsible for the operation of the irrigation substation. Dr. Larry O. Fine, head of the agronomy department, supervises the agronomic experimental work on the farm and Dr. Walter Lembke is in charge of drainage experiments.

The animal-feeding experiments are under the supervision of Dr. R. J. Walstrom, head of the SDSU Department of Animal Science. Economic studies and comparisons with dryland operations are supervised by Dr. Lloyd Glover, head of the economics department.

Good Public Relations

Dye has fun kidding university staff members about the hours they work while he is putting in 12- and 14-hour days during the busy season. He realizes these hours are necessary for the many duties required of him in operating the farm and maintaining good public relations. He is never too busy to stop and visit a few minutes with visitors, especially if they are interested in irrigation. This results in a steady stream of visitors at the farm from spring until fall, and, because the farm has been in operation for 15 years and has always been open to the public, many people just drive around and look at the crops and cattle to compare them with their own.

Lloyd Dye, his wife and five girls ranging in age from 11 to 21; and LeRoy Wenz and his wife and two children live on the farm the year around. Mr. Wenz is the equivalent of the hired man and is retained to assist the station superintendent in the operation of the place. He and Dye are able to handle all of the routine work on the farm except the research activities. Occasionally they hire additional help for haying or corn harvest.

Good irrigation practices and timely cultivation, combined with planned-crop rotations, have been all that was necessary to control weeds on the farm. Most of the farm ditches are filled before harvest and machinery goes back and forth across them with no trouble. After the crops have been planted in the spring and cultivated a time or two, the field ditches are opened again. This arrangement makes it possible to plow and plant larger fields and control weeds on ditch banks.

The Dyes have an excellent family garden, with enough sweetcorn and other vegetables for friends. Last year Mrs. Dye raised cabbages that weighed 13 pounds each. Tomatoes, cauliflower, cucumbers, and all common garden crops and flowers do exceptionally well. Lloyd's family thinks this is a good way to live and raise a family. Plenty of water and good management add up to a dependable yield of common crops each year.

If anyone is interested in what irrigation can do for the Oahe Unit in South Dakota they should stop in and visit Lloyd Dye. The coffee probably will be hot. # # #

(*"Improve Your Salty Soils"—Continued from page 53*)

the seedlings cannot compete with the salts for the soil moisture. In any case frequent irrigation helps.

Below are several crops which can be grown on salty soil:

HIGH-SALT TOLERANT

Field Crops	*Grasses*
Barley	Tall wheatgrass
Sugarbeets	Russian wildrye
Alfalfa	Slender wheatgrass
Sweetclover	Smooth bromegrass
	Western wheatgrass

MEDIUM-SALT TOLERANT

Field Crops	*Grasses*
Rye	Crested wheatgrass
Oats	Intermediate wheatgrass
Wheat	Tall fescue
Corn	Pubescent wheatgrass

Even though certain grasses have a high-salt tolerance, they, like sugarbeets, are hard to get started. They seem to do best when planted early and irrigated frequently.

Once these grasses are established and irrigated heavily—provided there is good drainage—the soil may improve enough in a few years to produce fair crops of barley, alfalfa, and beets.

Summary

Observe and recognize salt problem.

Consult county agent and SCS technician.

Test soil and utilize technical assistance.

Apply corrective measures or reclamation.

Maintain sound soil and water management practices. # # #

BATTENING DOWN THE HATCHES

by H. SHIPLEY, Associate General Manager of the Salt River Valley Water Users' Association

As Bob Mason, Bureau of Reclamation Engineer, passed by the Salt River Project office one day, he spied a couple of the boys sitting beside a desk yawning.

"Why don't you fellows stay home at night and get some sleep?" asked Mr. Mason.

"Look, my friend, if you were chasing floodwater half the night, you would probably be hitting the sack right now," was the reply. "But we are here to get out some reports for the Bureau."

Bob asked how it happened that they were out in last night's storm. So they told him how the Salt River Project controls desert floods which threaten the irrigation facilities and urban development within the project.

The cities within the project area constitute 42 percent of the population of the State of Arizona. This is a good reason for having trained personnel to put flood-control operations into effect.

Yesterday afternoon's storm was an example—

At 6 p.m., the dark thunderheads suddenly let loose on the hill areas northeast of the project. The radio operators in the Association Dispatching Center (referred to as A.D.C.) immediately sent out messages for the zanjeros to evaluate the extent of the storm.

Anderson in car 271 was asked by radio to head out to Paradise Valley and keep A.D.C. posted. At 6:06 p.m., Alford in car 206 was to scout the washes in Deer Valley and report back.

At 6:15 p.m., a report came in of heavy rain in the area of Granite Reef, and the forebay water was rising. Three minutes later, Anderson reported heavy rains in Paradise Valley—washes beginning to run. Storm heading west.

By 6:20 p.m., A.D.C. had advised the irrigation superintendent by radio of storm conditions. The superintendent tells the operator to call in the transmission supervisor, the construction and maintenance superintendent, and the recorder. Then he heads for A.D.C. himself. In the next 30 to 60 minutes, trained personnel—one or two to a location—are at their posts, checked in by their car radios and awaiting instructions.

At Communications

There also is emergency activity at the communication center on the hillside. This room is glassed-in on three sides and sits on the second story of the communications building. In one corner is a river-stage recorder which prints out in code the Salt and Verde River flows into the reservoirs. Adjacent to this is a remote-control supervisory console which operates radial gates 8 miles away, at the junction of three main canal systems. This remote supervisory control has proven to be invaluable during emergencies.

A long table in the center accommodates two radio operators with microphones and receivers, Howard Durst and Cliff Baker. Flanking them is a table that holds log charts for recording the chronology of events from all stations. On the backwall, facing the operators, is the large project map, backed with steel so that marking magnets can be placed to identify trouble crews and local rain and flood intensities.

The radio operators do an invaluable job of receiving and sending messages to the field personnel, and recording data in accordance with FCC regulations. If flood conditions get bad, they immediately alert the sheriff's office, local police department and people who have equipment or buildings in the river channel or wasteways. In the event the storm occurs during the day, they notify the schools that are adjacent to wasteways. These operators handle as many as 150 calls per hour.

Dunbar Chapman, the recorder from the Hydrology Division, puts on a headset in emergencies, and records pertinent field data. At the end of the storm period, he will summarize the data as to the water wasted into the river from each wasteway and into the diversion dam, the amount of free water delivered to the lands and the quantity of floodwater entering the system.

Bud Simser, the construction and mainte-

A night trouble crew works on the walkway above the steel guard, raking out objects which would impede the flow of the heavy murky waters.

nance superintendent, also listens in. It is his responsibility to determine how many trouble crews to call out, and if necessary, what heavy equipment is needed in the trouble areas.

Cliff Baker the transmission supervisor, is responsible for the release of water from the reservoirs on the Verde and Salt Rivers into the main canals, to the beginning of the lateral distribution system. This is a key position. He must appraise the field information continuously to be able to regulate the flow and not overload the canal systems.

Ezra Vines, superintendent of irrigation operations, is responsible for the overall field operations in relation to the transmission and distribution systems. It also is his responsibility to call out and assign as many field men as are needed to handle distribution of water within the project, and absorb as much local floodwater as possible into the irrigation system.

The men who work on the various wasteways have been trained in the operation of the controls and in measuring the amount of water diverted to the river. Recruited from the engineering department, they are able to follow the detailed instructions and schematic drawings of the operating works.

On the Main Wash

The project also is responsible for the operation of Cave Creek Dam which is a flood-control structure located on the main wash. This dam stops a portion of the foothill runoff that at one time inundated the State capitol. Frank Chambers, superintendent of irrigation services, usually heads out there and keeps A.D.C. posted as to the storm intensity, amount of runoff, and gives an estimate of when the ungated discharge will hit the main canal system. This information enables the men at A.D.C. to take the necessary steps to turn waste water out of the canal system ahead of the main Cave Creek Wash.

Until 10 years ago, the main objective of the operating personnel during a storm was to load the canals and laterals to the gunnels, and place as much water upon the irrigated lands as possible. However, this has changed. The original 240,000 acres of irrigated lands are now 160,000 acres of farmlands and 80,000 acres of urban development. Our main concern today is safety—safety of the communities within this Reclamation project. Our second concern is to conserve and put to beneficial use as much water as possible.

During the storm period, the supervisors at A.D.C. have other responsibilities besides the concern of water distribution.

Relief of the field men is of utmost importance. Under the existing union contract, if a man works a certain number of hours in a specified period, he doesn't report to work the following day. Since the operations are continuous, relief has to be provided so that manpower is available the following day to carry on normal activities. The supervisor also provides sandwiches and coffee to men in the field.

Once in a while some of us reminisce about the way things were a dozen years ago: 10-party telephone lines, communications failure after a second lightning bolt, and no radios. Compare this with the present remote supervisory gate control, two-car radios, one-party telephone lines and first-rate mobile equipment.

However, having replaced yesterday's inconveniences, we have assumed modern problems. Urban development, with its house roofs and paved parking areas, causes 1½ times greater rain runoff than do irrigated fields and desert lands.

So, the *Storm Patrol* is up until 2 or 3 o'clock in the morning "battening the hatches," Mr. Mason—getting ready for the next day's *routine operations*.

Hasta La Vista, Senor Roberto! We're glad you came by. # # #

Commissioner Breaks Ground For NEW RECLAMATION BUILDING

At ceremonies held November 18, 1964, signaling start of construction on the new Reclamation Engineering and Office Building at the Denver Federal Center, Denver, Colo., Commissioner Dominy told staff members at the building site: "You have earned this building by your competence."

The Commissioner said that the Denver staff had been "far too long in inadequate housing," adding that the new building would compare favorably with the housing provided for any other agency in the Federal Government.

Commissioner Dominy was joined by F. B. O'Hanlon, Sr., of M.S.I. contractors, in turning the first shovel of dirt for the building. The Commissioner was presented with a chromium-plated shovel, inscribed with his name, to commemorate the event.

An accelerated program in the postwar years of 1946–47, imposed an increased workload on the Chief Engineer's Office, which is responsible for the technical, design, construction and research activities of the Bureau. In meeting this increased program, a peak force of more than 2,600 employees in the Denver office was located in downtown Denver buildings, such as the 75-year-old Golden Eagle Building and garages on Welton Street and Broadway, the Equitable Building, Continental Oil Building, Film Exchange Building, Patterson Building and in the new Customhouse.

The staff and employees next took quarters at the Denver Federal Center, then known as the Denver Ordnance Plant, following transfer of the plant from the War Assets Corporation to the Public Buildings Administration. After a move, which required 1½ years, this has been the Chief Engineer's Office for more than 17 years.

Like the other Reclamation offices, the Denver office is now reaching record levels of efficiency in handling a much larger program with roughly half the staff of the 1947 organization. Even with this signal accomplishment, the new building—to stand 14 levels above Sixth Street, as shown in the artist's drawing—will provide efficient working facilities for 1,250 of the 1,450 employees

of the Denver staff. It will be a 110- by 210-foot concrete building, providing 372,300 square feet of space.

The modern new building will be completely air conditioned and soundproofed. Floor coverings will be vinyl asbestos, ceramic, quarry tile and terrazzo. Efficient assignment of space, high-speed elevator service, close proximity to the research facilities in building 56 and a cafeteria in the building all will assist in streamlining operations.

Prime architects for the building are Hellmuth, Obata & Kassabaum of St. Louis, associated with two Denver firms: Scott Associates, Architects; and Ketchum, Konkel, Ryan and Fleming, Engineers.

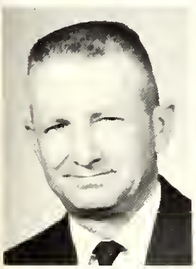
The construction contract for $5,825,035 was awarded to the M.S.I. Corp. of Wheaton, Md., lowest of 17 bidders. The time allowed for completion of the building is 2 years, with occupancy expected by the end of 1966. # # #

ERA Indexes Available

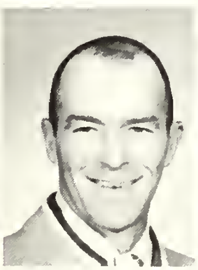
The index for all articles in the 1961, 1962 and 1963 issues of the *Reclamation Era* was printed in the November 1963 issue. Separate copies of the above index as well as some older ones are available upon request from the Bureau of Reclamation, Washington, D.C. 20240. Indexes are also included with the November issue every third year.

WITH THE WATER USERS

Presentations of the *Distinguished Service Award* of the Upper Missouri Water Users Association were made at the annual meeting held last December in Billings, Mont., to four men for their outstanding contribution to the cause of water conservation and utilization in the Missouri River Basin. Shown in the photo are awardees, from left, Fred E. Buck, Helena, Mont.; Einar H. Dahl, Watford City, N. Dak.; and L. F. Thornton, Thermopolis, Wyo. Presentation was by Vernon S. Cooper, right, president of the UMWUA. Millard G. Scott of Custer, S. Dak., not shown, also received the award, but was unable to be present to receive it.



Edward Hillis



George M. Glarborg

J. C. Flood

The *Outstanding Farmer Of The Year 1964* award and the *Grassman Of The Year* award of Minidoka County, Idaho, were presented at the annual banquet of the Rupert Chamber of Commerce, held last November. Two equally deserving men received the outstanding farmer award—Edward Hillis and George M. Glarborg—where ordinarily only one person receives it. Veteran homesteader Joseph C. Flood was the recipient of the grassman award. All three winners are from Reclamation's North Side Pumping Division, giving that division a clean sweep of such 1964 honors in the county. * * *

Four *Headgate Awards* were presented at the 14th Annual Four-States Irrigation Council Banquet, held in Denver, Colo., in January. In earning the award, the men distinguished themselves in service to irrigation and water conservation and development. They are shown in the photo, from left, Fred Wright, Monte Vista, Colo.; Ward Douglas, Courtland, Kans.; Earl Lloyd, Cheyenne, Wyo.; and James C. Adams, North Platte, Nebr. Reclamation Commissioner Floyd E. Dominy, right, gave the banquet speech.

Courtesy of the *Denver Post*

RECLAMATION EMBLEM IS ADOPTED

The official Reclamation emblem shown here has been approved by the Department. It will be used to identify Bureau facilities and office throughout the West.

The emblem features a stylized drop of water, in which appears a concrete dam, a reservoir which can be used for recreation and other uses, and water-yielding mountains in the background. At the toe of the dam, a hydroelectric powerplant is shown, and at the bottom appears an irrigated field of crops, thus symbolizing the multipurpose development and use of available water resources. The Department of the Interior and the Bureau of Reclamation are identified in a circular border.

MAJOR RECENT CONTRACT AWARDS

Specification No.	Project	Award Date	Description of Work or Material	Contractor's Name and Address	Contract Amount
DS-6170	Central Valley, Calif.	Feb. 26	Four motor generator voltage bus structures, two 600-volt station-service feeder busways, and two 2,000/2,300-kva station-service power transformers for San Luis pumping-generating plant, Schedule 1.	Westinghouse Electric Corp., Denver, Colo.	
DS-6170	do	Feb. 2	Eight switchgear assemblies for San Luis pumping-generating plant, Schedule 2.	Brown Boveri Corp., New York, N.Y.	295, 500
DC-6174	do	Jan. 25	Modification of Delta-Mendota canal, Mile 3.5 to 69.25.	Granite Construction Co., Watsonville, Calif.	2, 971, 173
DS-6180	do	Feb. 2	Furnishing and installing six 40,000-hp synchronous motors for Mile 18 pumping plant.	ASEA Electric, Inc., San Francisco, Calif.	3, 080, 725
DC-6181	Columbia Basin, Wasb.	Jan. 7	Construction of 23.2 miles of Wahlukc Branch canal laterals, wasteways, and drains, Blocks 21 and 48.	Kenneth E. Beck & Sons, Inc., Moses Lake, Wash.	926, 707
DS-6182	Colorado River Storage, Ariz.	Jan. 12	Four 230-kv and four 23-kv power circuit breakers for Pinnacle Peak substation.	Westinghouse Electric Corp., Denver, Colo.	318, 632
DS-6183	Colorado River Storage, Colo.	Feb. 17	One 48,000/64,000/80,000-kva power transformer for Blue Mesa powerplant.	ASEA Electric, Inc., San Francisco, Calif.	133, 114
DC-6184	Central Valley, Calif.	Jan. 29	Construction of 8.3 miles of pipelines and structures for Main aqueduct.	Baker-Anderson Corp., Santa Ana, Calif.	2, 660, 476
DC-6185	do	Jan. 13	Completion of San Luis pumping-generating plant and switchyard, and Forebay switchyard.	Gunther & Shirley Co. and E. V. Lane Corp., Sherman Oaks, Calif.	3, 775, 054
DC-6187	Navajo Indian Irrigation, N. Mex.	Feb. 1	Construction of Main canal and 5-mile tunnel No. 2, Schedule 3.	Shea-Kaiser-Maeco Redding, Calif.	8, 640, 411
DC-6188	Central Valley, Calif.	Mar. 15	Construction of concrete lining and structures for Forebay canal and wasteway, and modification of Delta-Mendota canal.	R. A. Wattson Co., Panorama City, Calif.	1, 335, 595
DC-6189	do	Jan. 25	Designing, furnishing, and erecting one steel storage tank for Main aqueduct.	Chicago Bridge & Iron Co., San Francisco, Calif.	246, 900
DC-6192	Missouri River Basin, Wyo.	Jan. 25	Construction of stage 04 additions to Lovell substation.	Capitol Electric & Engineering Co., Denver, Colo.	107, 679
DS-6194	Pacific Northwest Pacific Southwest Intertie, Ariz.	Jan. 6	700,000 linear feet of 1,033,500-circular mil ACSR conductor for Mead-Liberty 345-kv transmission line (non set-aside portion.)	Reynolds Metals Co., Richmond, Va.	242, 200
DS-6194	do	Jan. 12	2,000,000 linear feet of 1,033,500-circular mil ACSR conductor for Mead-Liberty 345-kv transmission line. (Negotiated contract; set-aside portion.)	Southwire Co., Inc., Carrollton, Ga.	692, 000
DS-6195	Colorado River Storage, Ariz.	Feb. 1	Two 236-kv shunt capacitor equipments for Pinnacle Peak substation, stage 02.	Sangamo Ele¢tric Co., Springfield, Ill.	115, 406
DS-6197	Navajo Indian Irrigation, N. Mex.	Feb. 5	Aerial photography, control and topographic maps for East Chaco lands (Gallegos Canyon area) (Negotiated contract).	Kucera & Associates, Inc., Denver, Colo.	225, 954
DC-6198	Silt, Colo.	Feb. 11	Construction of 7.6 miles of Silt pump canal	Western States Construction Co., Inc., Loveland, Colo.	304, 497
DC-6199	Central Valley, Calif.	Mar. 8	Construction of 62 miles of pipelines and structures, including reservoirs and six pumping plants, for Corning Water District distribution system.	Valley Engineers, Inc. of Fresno, Fresno, Calif.	4, 219, 354
DC-6200	Rogue River Basin, Oreg.	Mar. 11	Construction of Agate Dam	Sandkay Construction Co., Inc., Ephrata, Wash.	1, 128, 935
DC-6202	Missouri River Basin, Wyo.-Nebr.	Jan. 29	Construction of 16 miles of 115-kv taplines for Archer and Stegall substation areas.	Patrick Harrison, Inc., Golden, Colo.	145, 710
DS-6207	Pacific Northwest-Pacific Southwest Intertie, Nev.	Feb. 3	Location, surveys, maps, and geology for 750-kv direct-current transmission line, Beatty to Luning, Nev., Section 2. (Negotiated contract.)	R. W. Millard & Associates, Inc., Ely, Nev.	112, 069
DS-6209	Office of Economic Opportunity, Ill.-Calif.	Feb. 2	Furnishing and erecting dormitory complex, office and staff quarters complex, dispensary, supply room and commissary, and messing complex for Crab Orchard and Toyon Rural Job Corps Conservation Centers, Schedules 3 and 4. (Negotiated contract.)	Magnolia Mobile Homes Sales Corp., Vicksburg, Miss.	584, 093
DS-6209	Office of Economic Opportunity, N. Mex.	Mar. 26	Furnishing and erecting dormitory complex, office and staff quarters complex, dispensary, supply room and commissary, and messing complex for Mexican Springs Job Corps Conservation Center, Schedule 1. (Negotiated Contract.)	G. T. Wolfe Mobile Homes, Inc., Corona, Calif.	436, 058
DC-6212	Eklutna, Alaska	Feb. 1	Rehabilitation of intake structure and conduit for Eklutna pressure tunnel.	Manson-Osberg Co., Seattle, Wash.	633, 631
DC-6215	Colorado River Storage, Colo.	Feb. 18	Construction of 9 miles of Curecanti-Crystal 115-kv transmission line and temporary 115-kv tieline at Curecanti substation.	Malcolm W. Larson Contracting Co. Denver, Colo.	317, 374
DS-6217	Pacific Northwest-Pacific Southwest Intertie, Nev.	Feb. 18	250,000 linear feet of 2,300,000-circular mil ACSR conductor for Oregon Border-Mead 750-kv direct-current transmission line.	Kaiser Aluminum & Chemical Sales, Inc., Oakland, Calif.	233, 00
DC-6220	Colorado River Storage, Ariz.	Mar. 4	Construction of Flagstaff substation, stage 01.	Howard P. Foley Co., Inc., Tucson, Ariz.	529, 50
DS-6221	San Juan-Chama, N. Mex.	Mar. 1	Four 5-foot by 9-foot high-pressure gate valves, four hydraulic hoists, and two gate hangers for outlet works at El Vado Dam.	Steward Machine Co. Inc., Birmingham, Ala.	241, 00
DC-6222	Canadian River, Texas	Mar. 17	Construction of 35 miles of pipelines for East aqueduct, and pumping plants No. 5 and 6.	Allison & Haney, Inc., Albuquerque, N. Mex.	4, 114, 45
DC-6223	Weber Basin, Utah	Mar. 8	Construction of traveling water screen structure for Gateway canal.	E. Arthur Higgins, Salt Lake City, Utah.	134, 81
DC-6225	Parker-Davis, Ariz.	Mar. 25	Construction of stage 02 additions to Maricona substation.	Douglass Bros., El Paso, Tex.	279, 86
DS-6230	Office of Economic Opportunity, Ky.	Mar. 18	Furnishing and erecting dormitory complexes, office and staff quarters complexes, dispensaries, supply rooms and commissaries, education and recreation complexes, and messing complexes for Great Onyx Job Corps conservation center No. 285 and Cumberland Gap Job Corps Conservation Center No. 257, Schedules 1 and 2.	Magnolia Mobile Homes Sales Corp., South Hill, Va.	816, 99
DS-6230	Office of Economic Opportunity, Idaho.	Mar. 11	Furnishing and erecting dormitory complex, office and staff quarters complex, dispensary, supply room and commissary, education and recreation complex, and messing complex for Mountain Home Job Corps Conservation Center, Schedule 5.	Bunting Tractor Co., Inc., Tel Star Division, Boise, Idaho.	454, 46
DS-6230	Office of Economic Opportunity, Ariz.-Utah.	Mar. 12	Furnishing and erecting dormitory complexes, office and staff quarters complex, dispensary, supply room and commissary, education and recreation complex, and messing complex for Winslow Job Corps conservation center and Price Job Corps Conservation Center No. 327, Schedules 3 and 6.	Utah Mobile Homes, Inc., Salt Lake City, Utah	344, 83

U.S. GOVERNMENT PRINTING OFFICE: 1965 O—765-425

MAJOR RECENT CONTRACT AWARDS—Continued

Specification No.	Project	Award Date	Description of Work or Material	Contractor's Name and Address	Contract Amount
DC-6240	Eklutna, Alaska	Mar. 26	Replacement of Eklutna Dam	A & B Construction Co., Helena, Mont.	1,233,470
DS-6244	Pacific Northwest-Pacific Southwest Intertie, Nev.	Mar 18	750,000 linear feet of 2,300,000-circular ACSR conductor for Oregon Border-Mead 750-kv direct-current transmission line.	Rome Cable Corp., Rome, N.Y.	692,250
100C-743	Columbia Basin, Wash	Mar. 15	Construction of 11 miles of buried pipe drains for D20-61 and D20-61-1 drain systems and deepening WB5WW2 and WB5HHWW wasteways, Block 20.	Sandkay Construction Co., Inc., Ephrata, Wash.	204,928
300C-219	Colorado River Front Work and Levee System, Ariz.	Feb. 18	Construction of 0.6 mile unlined channel, 2.8 miles of cast-in-place concrete pipelines, and structures for drainage pump outlet channel No. 4, Schedule 1.	Concrete Ditch Lining Service, Inc., Phoenix, Ariz.	171,328
300C-223	do	Jan. 11	Extension of riprap for Yuma Valley Levee	Wennermark Co. and Emmet J. Harris, San Bernardino, Calif.	327,100
300C-225	do	Feb. 18	Construction of haul roads and bank protection structures for Palo Verde Division.	Karl A. Dennis, d.b.a. Dennis Construction Co., Yuma, Ariz.	517,890
400C-279	Colorado River Storage, Colo.	Jan. 15	Clearing 9,180 acres of Blue Mesa reservoir	Humphrey Contracting Corp., Wichita, Kans.	110,000
DS-6235	Central Valley, Calif	Mar. 30	Eight unit control boards, one control console, one main control board, one desk, one switchyard control and relay board, and two carrier relaying transmitter-receiver for San Luis pumping-generating plant.	Westinghouse Electric Corp., Denver, Colo.	223,079
DC-6238	Colorado River Storage, Ariz.-Utah.	Mar. 30	Constructing 69-kv and microwave power supply additions to Glen Canyon switchyard.	Tide-Bay, Inc., Tacoma, Wash.	108,016

Major Construction and Materials for Which Bids Will Be Requested Through August 1965*

Project	Description of Work or Material
Arbuckle, Okla	Constructing the Wynnewood Pumping Plant with a capacity of 9.5 cfs and a 190-ft head; and constructing about 20 miles of 10-, 21-, 24,- and 27-in.-diameter pipelines for heads up to about 200 ft. Near Davis and Wynnewood.
Central Valley, Calif.	Completion work for the Mile 18 Pumping Plant.
Do	Constructing about 17 miles of unreinforced-concrete-lined canal with bottom width varying from 52 to 24 ft, including monolithic concrete box siphons, bridges, culverts, pipe irrigation crossings, drainage inlets, etc. Tehama-Colusa Canal, Reach 2, near Corning.
Do	Constructing about 9.4 miles of San Luis Canal, Reach 4, with a bottom width of 60 ft, to be lined with 4.5-in. unreinforced-concrete lining. Work will also include constructing bridges, irrigation crossings, and turnouts. Near Huron.
Do	Constructing about 3,000 lin ft of the Delta-Mendota concrete-lined canal with a bottom width of 48 ft and lining height of 19 ft 2 in., canal to be lined with 4-in. unreinforced concrete; and constructing a state highway bridge 215 ft long, 50 ft wide, with prestressed concrete end spans and one structural-steel plate girder central span with reinforced-concrete deck; and concrete footings and concrete piles for two piers for each of five other bridges to be constructed across the canal by others at a later date. Near Tracy.
Do	Work will consist of removing a reinforced-concrete bridge abutment and one 116-ft-long steel girder span with concrete deck, both of which have been damaged by flood flows in the Trinity River, and reconstructing a new reinforced-concrete abutment and one 116-ft-long steel girder span with concrete deck to be connected to an existing cantilever span with a hanger. Work will also include constructing an earth embankment along river channel with riprap protection. Near Carrville.
Do	Six 14.4-kv, station-type switchgear; 15-kv isolated-phase bus; two 1,500-kva, 13.2-kv to 480-volt, station-service transformers; and 600-volt non-segregated-phase bus. All for Mile 18 Pumping Plant.
CRSP, Arizona	Additions to the Pinnacle Peak Substation will consist of constructing foundations; furnishing and erecting steel structures; installing one 600-mva, 345/230-kv autotransformer, 12 single-phase, 8,000-kva shunt reactors, and five 230-kv and four 23-kv circuit breakers; and furnishing and installing associated electrical equipment. About 20 miles northeast of Phoenix.
CRSP, Arizona	Constructing the Glen Canyon Dam Visitor Centel complex will consist of constructing a one-story steer frame and precast Mo-Sai panels Visitor Center building of about 11,250 sq ft, a parking area for about 120 cars, a vertical-shaft in rock for housing elevators descending about 100 ft to a lobby and horizontal tunnel, also in rock, to provide access to the crest of the dam. An auditorium seating about 90 persons will be included in the plan for Schedule No. 1 and will be omitted in the plan for Schedule No. 2. Two elevators each of about 40-passenger capacity will be furnished and installed under a separate contract. At Page.
CRSP Colorado	Completion work for the Blue Mesa Powerplant and Switchyard will consist of placing concrete for turbine embedment and generator support; installing two 41,500-hp, 200-rpm, vertical-shaft, hydraulic turbines, the transformer bank, switchyard and other mechanical and electrical equipment; constructing interior masonry wall partitions; placing concrete floor surfacing, and applying architectural finishes. About 25 miles west of Gunnison.
Do	Three single-phase, 230/12-kv, 53-mva, FOW transformers for Morrow Point Switchyard.
Fryingpan-Arkansas, Colorado	Constructing the Divide, South Fork, and Chapman Tunnels. The Divide Tunnel will have about a 10-ft 6-in. diameter concrete-lined section and will be about 5.3 miles long; the South Fork Tunnel will have about an 8-ft-diameter concrete-lined section and will be about 3.1 miles long; and the Chapman Tunnel will have about a 7-ft-diameter concrete-lined section and will be about 2.6 miles long. Work will also include constructing three small ogee weir diversion dams and buried free-flow conduit and pressure pipelines. Near Aspen.
MRBP, Kansas	Twelve 50- by 21.76-ft radial gates for Glen Elder Dam. Estimated weight: 1,066,000 lb.
MRBP, South Dakota.	Additions to the Sioux Falls Substation will consist of constructing foundations; furnishing and erecting steel structures; furnishing and installing three, single-phase, 230/115/13.2-kv, 33,333-kva autotransformers, one 3-phase, 115-kv, 75,000-kva regulating transformer, three 13.2-kv, 4,000-kva reactors, two 230-kv, one 115-kv, and one 13.2-kv circuit breakers, and associated electrical equipment. About 4 miles northeast of Sioux Falls.
Pacific Northwest-Pacific Southwest Intertie, Calif.	Constructing the single-unit, 3-phase, 500-kv Oregon border-Round Mountain Transmission Line about 94 miles long. Extending from the vicinity of Round Mountain, Calif., to a point on the Calif.-Oregon border about 7 miles east of Tulelake, Calif.
Pacific Northwest-Pacific Southwest Intertie, Nevada.	Twenty-two 230-kv, 20,000-mva power circuit breakers for Mead Substation.
Pondera County Canal and Reservoir Co., Montana.	Constructing Swift Dam, a concrete thin-arch structure, about 205 ft high and 560 ft long, and appurtenant features. On Birch Creek, about 45 miles west of Conrad, Montana.
San Juan-Chama, Colo.-N. Mex.	Constructing about 8 miles of concrete-lined Blanco Tunnel of either 8-ft 3-in. diameter horseshoe section or 8-ft 7-in. diameter circular section; and constructing the reinforced-concrete Blanco Diversion Dam consisting of an ogee overflow weir, sluiceway, and headworks. Near Pagosa Springs.
Spokane Valley, Wash.	Constructing about 85 miles of 6- to 24-in.-diameter pipelines for hydrostatic heads up to 250 ft. The pipelines will be either pretensioned concrete pipe, asbestos-cement pipe, or steel pipe. Near Spokane.

*Subject to change.

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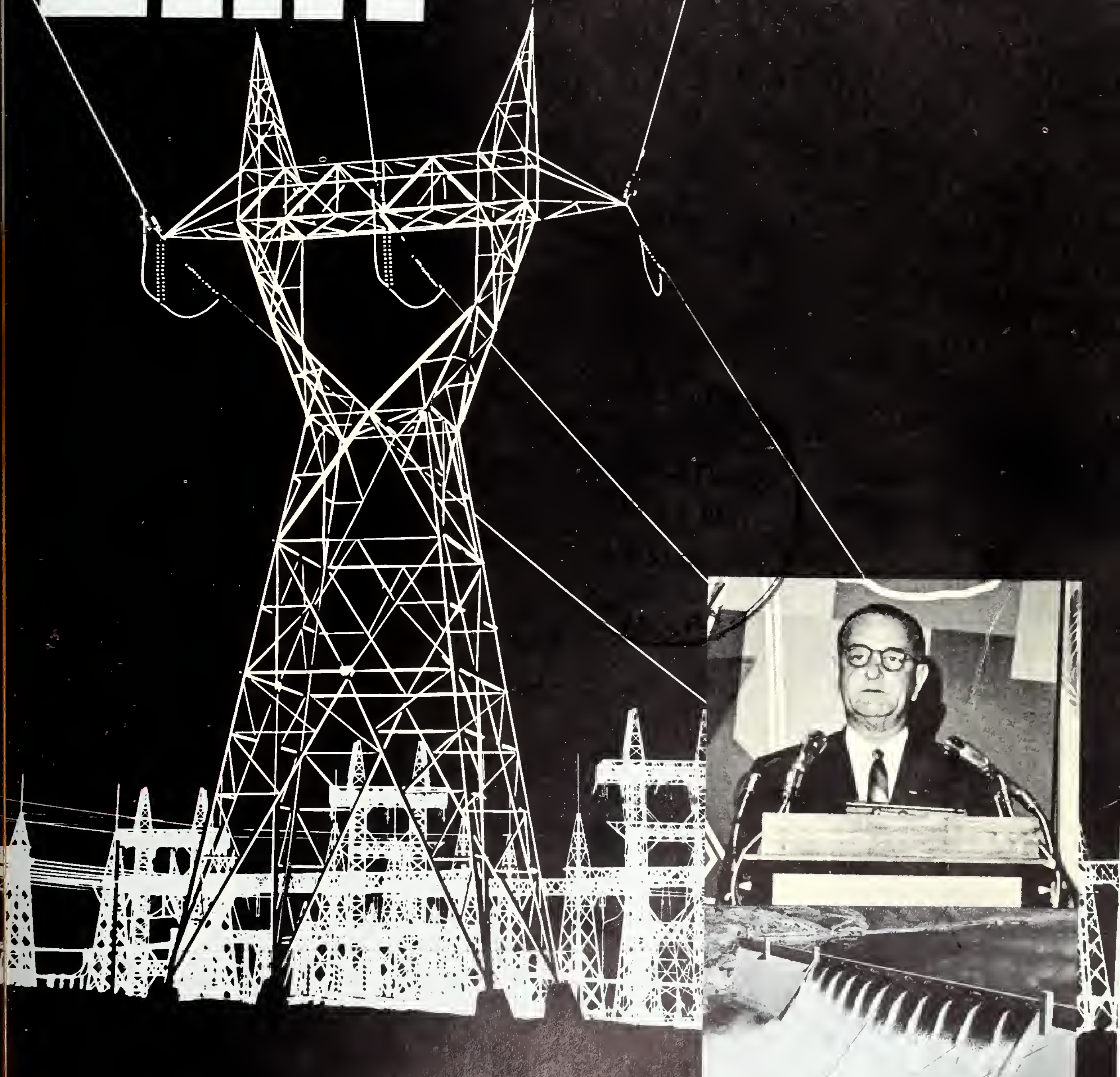
In its assigned function as the Nation's principal natural resource agency, the Department of the Interior bears a special obligation to assure that our expendable resources are conserved, that renewable resources are managed to produce optimum yields, and that all resources contribute their full measure to the progress, prosperity, and security of America, now and in the future.

U.S. Department of the Interior
Bureau of Reclamation

RECLAMATION

ERA

August 1965



In This Special Issue—

New Impetus for the West:
The Electric Power PNW-PSW Intertie

The most exciting transmission system in history . . .

"This intertie which is the result of so many brains and so much work, and such great efforts, is the most exciting transmission system in history. It will make us world leaders in direct current transmission. It will carry from the Peace River to the Mexican border enough power for five San Franciscos. So I come here to tell you, and to tell each of you, that all America is proud of all of you.

"I am glad to see this cooperation of private power with public power. The public power yardstick is essential. Private power will always play a substantial and a vital role in the future of this great land. This system is also proof of the power of cooperation and unity. You have proved that if we turn away from division, if we just ignore dissension and distrust, there is no limit to our achievements.

". . . But we must do more than continue. Our problems are changing every day and we must change to meet them. . . . By the year 2000, more than 300 million Americans will need 10 times the power and two-and-one-half times the water that we now consume.

". . . The eyes of the Nation are looking to you to provide the leadership that will not just make this the best conservation Congress we have ever had, but that will help us to bring our dreams of a more beautiful America, a safer America, a healthier America available to our children as it has been available to us."

President Lyndon B. Johnson
September 17, 1964
Portland, Oregon

The full benefits of electrical integration . . .

"In the truest sense, the Pacific Northwest-Pacific Southwest Intertie is a conservation measure. It will conserve energy, capital, manpower, and materials—the ingredients of a strong, healthy economy. The plan brings together the forces of public and private power for the welfare of our Nation. With this kind of cooperative spirit, we will move forward together to give the American people the full benefits of electrical integration and maximum efficiency."

Stewart L. Udall
Secretary, Department of the Interior
July 1, 1964
Washington, D.C.

Reclamation ERA

AUGUST 1965

Volume 51, No. 3

OTTIS PETERSON, Assistant to the Commissioner—Information

GORDON J. FORSYTH, Editor

COVER PHOTOS. Signaling a final stage of agreement on the plans for the Pacific Northwest-Pacific Southwest Intertie, President Lyndon B. Johnson voiced his wholehearted endorsement of it. His speech is printed, in part, on the inside of the cover. Also representing the precedent-setting Intertie, is the spectacular photograph of a transmission facility, and the picture of Grand Coulee Dam and Powerplant, Washington.

United States Department of the Interior
Stewart L. Udall, Secretary

Bureau of Reclamation, Floyd E. Dominy, Commissioner

Washington Office: United States Department of the Interior, Bureau of Reclamation, Washington, D.C., 20240.

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Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C., 20240. Use of funds for printing this publication has been approved by the Director of the Bureau of the Budget, January 31, 1961.

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C., 20402. Price 30 cents (single copy.) Subscription price: $1.00; 25 cents additional for foreign mailing.

ABOUT THE AUTHORS . . . The special articles on these pages were written by eminent scientists and technical leaders in the field of electric power and high voltage transmission. The six authors did very well in attempting to adapt technical language to terms understood by the average reader. The editor is indebted to these men for their efforts and hopes that the further simplification in final editing will not lead to an inaccurate impression of the subject they know so well.

After noting this editor's confession to the problems involved in communication of a very complex subject, we hope even our most distinguished contemporaries will find interest at each turn of the page. This is a story of modern engineering achievement in our time.

One of the key officials in planning and development of the Pacific Northwest-Pacific Southwest Intertie, Commissioner Dominy tells the story of the evolution of the transmission giant capable of carrying the output of two Grand Coulee Powerplants.

A New Power Giant Materializes on the West Coast

by COMMISSIONER FLOYD E. DOMINY

THE Pacific Northwest-Pacific Southwest Intertie is the biggest single electrical transmission project ever undertaken in this country.

Stretching from the Columbia River to Hoover Dam and Los Angeles, four big gleaming lines of the new system will carry more than 4 million kilowatts, southward or northward. This is the equivalent of the output of two present Grand Coulee Powerplants!

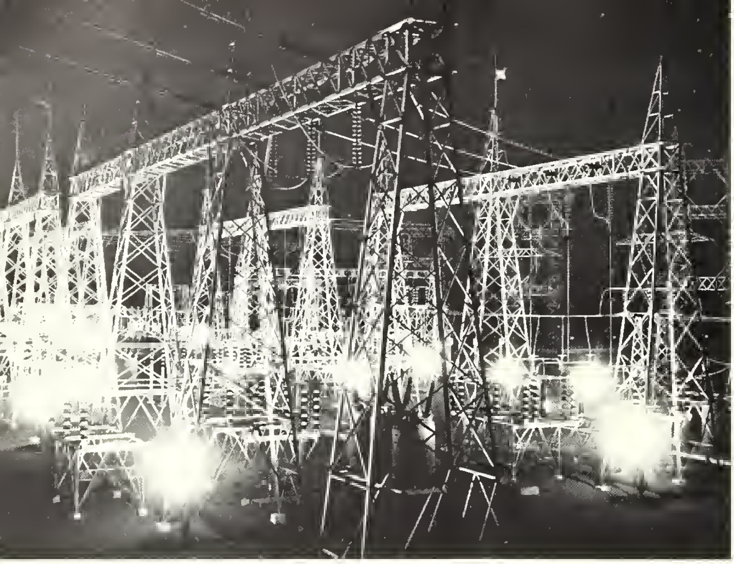
The lines will tie together electric systems—public and private—all the way from Vancouver, B.C., and Seattle to Phoenix, Arizona, and California points, including the biggest Federal hydro system in America, the biggest municipal system, and the biggest group of private systems in the West. These systems are respectively: the Federal Columbia River Power System, the Los Angeles Department of Water and Power, and the private California Power Pool.

The Intertie system will benefit the people in 11 western States, especially the customers of many small rural electric cooperatives, municipal systems and other public agencies—about 250 distributors in all. Also, it will reduce the waste of hydroelectric kilowatt-hours over dam spillways in the Pacific Northwest, and will promote a maximum of electrical efficiency throughout those States.

Two of the four big Intertie lines will be direct current lines, America's first and the world's longest. This project will make our Nation the world leader in an exciting new transmission technique.

Precedent Broken

For many years there has been general agreement on the need for a great new power tie line in the far West. However, conflicts in regard to control and sharing of benefits long delayed progress on it. With the conflicts now largely resolved, the PNW-PSW Intertie has become a precedent-breaking joint endeavor of Federal, public and pri-



The giant structural webbing of this transmission facility luminesces startlingly beautiful at night.

vate power organizations. In addition, area rights have been spelled out in special legislation, while agreements by agencies have been reached on the distribution of benefits to all power consumers. Construction is now in progress, and the first kilowatts will shoot through the new Intertie in late 1967.

The primary purpose of the Pacific Intertie is to coordinate operation of all utility systems in the area so as to obtain maximum overall utilization and efficiency of the generating capacity. And even the smaller utilities, which might otherwise face strong economic competition, will receive maximum benefits.

In the early years of the United States-Canadian Treaty, power from joint Upper Columbia River developments will be marketed in California, Nevada, and Arizona. This power will not only be available to the residents of those States who are increasingly using air-conditioning in their homes and offices, but the kilowatts also are now being contracted for by irrigators in the giant Central Valley Project, presently being enlarged and improved. The Bonneville Power Administration (BPA), which acts as a balance wheel in marketing Federal power in the Northwest, will give aid to other agencies, and will itself, receive aid.

Bureau of Reclamation projects on the Colorado River almost completely control that stream for water and power production and are tied into a large power network of mainly steam-electric plants. In this regard, the Intertie will result in savings of installed steam-electric capacity, further use of surplus Northwest energy to save fuel, and power and energy exchanges from the Southwest to firm up capacity in the Northwest.

Early Program Expands

The earliest plans for a Federal transmission line between the BPA grid and the northern California systems envisioned the same important general purposes as today's larger PNW-PSW Intertie system. However, a greater load growth and technological advances of recent years have added other major uses to be considered, and have required redesigning of facilities. Where only one 230,000-volt line with a capacity of about 150 thousand kilowatts was planned back in 1935, four extra-high voltage lines are now being constructed with a total capacity of up to 4.6 million kilowatts.

I remember in 1935, when Grand Coulee and Bonneville Dams were under construction, that there was talk about interconnecting electrical energy from those dams and non-Federal plants to California's Central Valley power, a few hundred miles south. It was anticipated that the Central Valley system would expand northward and meet the other grid part way. This idea was included in a report called "The Columbia Basin," 1935, by the Pacific Northwest Regional Planning Commission, a Federal agency.

The possibility of such interregional movements of power also was discussed in a Corps of Engineers' Review Report on the Columbia River, published in 1948. "Such interconnections," the Engineers' report said, "will obtain economies from diversity of loads and streamflows and the exchange of surplus energy or power."

Reclamation Finds Plan Feasible

A report on the first detailed investigation of a possible intertie between the Bonneville (BPA) system and the Central Valley Project was released by the Bureau of Reclamation in 1949. The Bureau found that an interconnection to close the gap of 217 miles which then separated the two systems—that is, from Roseburg, Oregon, to the Shasta switchyard—was economically feasible and desirable.

Diversity of loads and resources made the Bonneville and Central Valley systems complementary. By a process of displacement from one area

All the electric utility systems in the 11-State area, shown in the meandering blue lines, will be coordinated operationally when the Intertie, shown in black, is completed.

to another, large blocks of power could be shifted up and down the Pacific Coast.

The Bureau cited as another major benefit of the interconnection standby service to be provided by each system for the other. In case of failure of a substantial amount of generation or transmission in one region, the other could make up all or part of the deficiency from its reserve or other available resources.

A basic assumption of the Bureau report was that no energy would be exported from either area which could be used at home. And, once imported, the energy was not to be used to expand a market, but only to offer more reliable and more economical service to the already existing market.

In May 1952, the Federal Power Commission was requested by the Defense Electric Power Administration to study the feasibility of a Bonneville-California interconnection. The Commission report, issued in March 1953, reaffirmed the economic feasibility of an intertie between the two regions. The FPC proposed an interconnection of one or two 230-kilovolt lines. Dollar benefits would exceed the cost by appreciable amounts.

Development Plans Stalled

Despite the reports of Reclamation and the Federal Power Commission showing the economic and engineering feasibility of a Pacific Northwest-California intertie, the proposal made no headway. The idea became impractical when Bonneville's Yamsay-Klamath Falls line was sold to the California Oregon Power Company, thus preventing the Bonneville system from reaching the California border as originally contemplated.

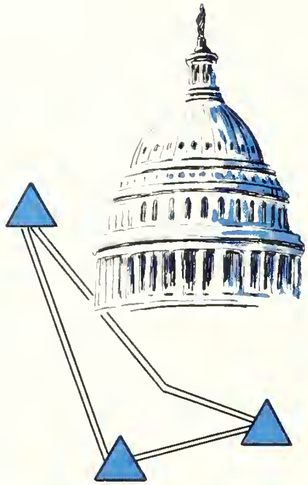
Although the Bonneville system had grown, there was no new power market in the Pacific Northwest, and this resulted in a waste of potential power generation. At the same time, rising costs of power facilities and decrease of secondary energy sales brought growing financial deficits to Bonneville Power Administration, so that it became urgent to find outlets for surplus power, or resort to rate increases.

In 1959, Bonneville negotiated for a California-Oregon power line, with the Pacific Gas and Electric Company as the builder. When this proposal was made public, various groups questioned the desirability or adequacy of such a plan.

The projected contract was held in abeyance at the request of the Subcommittee on Irrigation and Reclamation of the Senate Interior and Insular Affairs Committee, which held hearings on the proposed intertie in April 1959. At the conclusion of the hearings, the Committee adopted a resolution requesting the Secretary of the Interior to direct the Bonneville Power Administration and Bureau of Reclamation to make a study of the California tie, for the "disposal of surplus secondary energy."

An Interior report issued in February 1960 indicated the feasibility of an interconnection for the sale of surplus energy in California. The re-

The late President John F. Kennedy, directed Interior Secretary Udall to develop final plans for the Intertie.



The U.S. Congress appropriated funds to initiate construction of the Federal portions of the Intertie on August 14, 1964.

port stated that one 230-kilovolt circuit would yield the largest revenue as compared to cost.

Governors Request Time

At public hearings of the Senate Interior Committee, the Governors of California, Oregon, and Washington made their interest known on the matter and requested time for further study.

The State of California, in 1960, made an examination of a possible Pacific Northwest-Pacific Southwest tie, including all uses and benefits of such an interconnection, rather than just the sale of surplus secondary energy from the Pacific Northwest. A high-capacity intertie from the system of Bonneville Power to Southern California was recommended.

In early years of the United States-Canadian Treaty, power from the joint Upper Columbia River developments will be marketed in the Southwest—a valuable agreement.

In his message to the Congress on natural resources on February 23, 1961, the late President John F. Kennedy stated:

"Finally, I have directed the Secretary of the Interior to develop plans for the early interconnection of areas served by that Department's marketing agencies with adequate common carrier transmission lines; to plan for further national cooperative pooling of electric power, both public and private; and to enlarge such pooling as now exists." Within a few weeks Secretary of the Interior Stewart L. Udall appointed a special Task Force to indicate studies to implement the President's instructions. And in its report of December 15, 1961 this Task Force recommended construction of the PNW-PSW Intertie at the earliest practicable time and specified the features, uses, and purposes of the development.

Negotiations were to commence by the Bonneville Power Administration and the Bureau of Reclamation with utilities, public and private, that desired to participate in the program.

In the spring of 1964, Assistant Secretary Kenneth Holum established the criteria for an important Federal yardstick to be used in evaluating Intertie construction proposals.

Thus the technological problems inherent in an electrical intertie transmitting power between the Pacific Northwest and the Pacific Southwest appeared capable of solution. However, in the Northwest strong opposition developed to the building of such a distribution system without a reservation of a future power supply to the area of origin. On the other hand, a regional preference clause of this sort was unacceptable to some supporters of the Intertie.

Senator Henry Jackson of Washington stepped into this seeming impasse and introduced in the Senate a bill to guarantee electric consumers of the Northwest first call on electric energy generated at Federal hydroelectric plants in that region and to give consumers in other regions reciprocal priority. While the measure was under consideration, Congress appropriated funds to initiate construction of the Federal portions of the Intertie, subject to enactment of some such legislation.

Under Senator Jackson's outstanding leadership, both as chief sponsor of the preference bill and as Chairman of the Senate Committee on Interior and Insular Affairs, a version of the measure

The $20 million shown wasting in the sea is the value of the potential electric power that could have been obtained, had there been a market for it—a market the PNW–PSW Intertie will provide in the Southwest.

finally passed both houses of Congress in the summer of 1964, and was signed into law by President Lyndon B. Johnson. Thus the path was cleared for the building of the long-heralded Pacific Northwest-Pacific Southwest Intertie.

Starting almost immediately after the plan was approved by Congress, geologic and aerial surveys began for the Bureau of Reclamation lines and terminals at actual field locations. And in the last several months, Reclamation has awarded contracts for several million feet of conductor cable for high voltage lines to firms in New York, Virginia, and in Oakland, California. A contract for two direct-current terminals—the first in the United States—was awarded to two cooperating American and Swedish manufacturers.

Other milestones between now and next February will be the awarding of the first contracts for constructing spans of the Reclamation lines.

With such work already underway, a new power transmission giant will materialize in a few short years in the American West. # # #

Floyd E. Dominy. An internationally recognized authority on land and water resource development, Floyd E. Dominy has served in the Bureau of Reclamation nearly 20 years, as Commissioner since 1959. Under his stewardship the Bureau has made great strides in the field of hydropower. Commissioner Dominy has visited various hydroelectric facilities in foreign countries, comparing them with ours and has presented numerous papers and addresses on hydro-power to international, as well as national, professional and lay audiences.

Although the men who construct the Intertie may not have this view when they get to the Death Valley National Monument, they will build a 750-kilovolt, d-c line nearby.

Researching the Intertie

by E. V. LINDSETH

Experimental work in extra high voltage transmission has been done by the Bureau of Reclamation, and by others in this country and in Europe. Specific research on problems associated with the Intertie has been and is being done in Bureau laboratories—and, as is usual in construction of a new electrical system, more will be done as the giant Intertie is being built.

ONE of the most exciting fields of research is in the transmission of extra-high voltage electric power—500 to 750 kilovolts.

Since the early discoveries on distribution of electricity, advancements in the use of this great unseen energy have been occurring at an increasing rate. Higher and higher voltages have become very important to industrial production and to the daily needs of modern living.

Improvements have been needed continually in design and construction of transmission lines, and in operation of power facilities. The experiences of the Bureau of Reclamation, and many other groups concerned with electrical energy production and transmission have proven most useful through the years.

Researching the Pacific Northwest-Pacific Southwest Intertie has called for the use of science's most intricate tools. Such equipment as network analyzers and computers have been employed in planning and designing. The Bureau's network analyzer electronically duplicates aspects of powe[r] systems in miniature. With this miniaturization it is possible to determine the functional character-

Bureau of Reclamation crews making preliminary surveys near th[e] proposed Mead Substation near Boulder City, Nev., in preparatio[n] for construction of an Intertie line.

Intertie experiments in the Bureau laboratories at Denver, Colo. involve considerable work with models. Paul Ottens is attachin[g] a string of insulators on this miniature of a 162-foot-high tower while Roger Robert Dorcas, a section chief, observes.

Initial drilling, sampling, and testing of foundation conditions for steel tower transmission lines and substations. Geologists are taking a sample of materials removed from the hole with a bucket auger.

istics of the alternating-current system before it is even built.

A model of the direct-current circuitry of the Intertie was built in the Bureau's laboratories and tested for compatibility with the alternating-current system.

Bureau engineers, working in cooperation with engineers of the Bonneville Power Administration and other utilities from the Canadian border to southeastern Arizona, will solve problems involving transmission distances two to three times greater than those previously experienced.

Existing technology must be extended, and the new direct-current transmission must be designed to work compatibly in parallel with the alternating-current system.

Mercury Still Best

A major advance in direct-current transmission technology occurred when the mercury rectifier provided a means of converting alternating-current to direct-current. This was done by P. C. Hewitt, and the mercury type still is best for high voltage. In 1905, Dr. C. P. Steinmetz, then of the General Electric Company, developed mercury rectifiers to supply street lighting in Schenectady, New York. That company's 17-mile-long direct-current transmission line from Mechanicville, to Schenectady, New York, operated from 1936 to 1945.

At one time, direct-current was the established means of delivering and using electric power, but technical difficulties limited its use.

Direct-current has had limited use because it could not be readily changed from one voltage to another to meet the consumer's needs and requirements for transmission.

Alternating-current voltage, on the other hand, could be increased or decreased through the use of relatively inexpensive transformers. Largely for this reason, the commercial and industrial use of electricity in this country began long ago switching over to alternating-current. Among the last holdovers were low-voltage direct-current distribution systems serving the trolley cars and buses then in operation.

As the name implies, direct-current is a steady flow of current in one direction only. Alternating-current is basically a current of electricity which reverses (or alternates) its direction of flow at established intervals.

Back To D-C

And now, becoming involved in one of the greatest electric transmission programs in history, we find ourselves turning to direct-current, to help get the job done. It may be asked, "Why do we bother with d-c if it has such limited use?" The answer is that it also has advantages. Actually, we will be using the best features of both systems.

With the reintroduction of direct-current into the electric transmission field, the Bureau undertook a number of technical studies to increase the available knowledge of d-c and obtain firsthand experience with its use, particularly in the areas of very high voltages.

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Direct-current transmission normally operates with all current circulating through the two metal conductors. However, a great advantage of this system, not practical with alternating-current, is that by using earth return, it can carry half capacity between terminals when one of the conductors is out of operation, either by malfunction or for maintenance.

During preliminary tests conducted in 1963 and more detailed tests in 1964, direct-current was circulated through the earth between points at Shasta Dam and a point near Tracy in California; and between Hoover Dam and points throughout the vicinity into southern California. The Hoover Dam tests were utilized by the U.S. Geological Survey to supplement its data on electrical properties of the earth's crusts in the region, and the U.S. Air Force collected similar data.

Results of these tests will be used by the Bureau to protect against corrosion of such buried structures as gas, oil and water lines in the proximity of the transmission line. Corrosion, or rusting of buried metal, is fundamentally an electrical or electro-chemical process. Certain metals, reacting to dissolved salts in the soil, set up destructive electric current which will dissolve portions of the metal. This dissolved metal, upon exposure to air or oxygen, produces rust.

Electrically induced corrosion can be controlled by burying metal rods with a greater electric potential than the metal to be protected, which attracts the destructive currents, protecting the structure. Occasionally, these metal rods, or the metal to be protected, are connected to an external source of low-voltage direct-current to cancel out ground currents. These techniques are known as "cathodic protection."

Bureau tests revealed that direct-current fed into the earth will not produce higher currents than the capacity of cathodic protective devices currently in general use.

More D-C Advantages

Grounding of high-voltage direct-current lines would not adversely affect railroad safety or signal systems, and it is now known that normal design provisions for filtering will prevent telephone and radio interference. Further investigations are being conducted to determine design criteria to protect other power transmission systems from disturbance by the grounding of high-voltage direct-current.

The Bureau designed a new, self-supporting steel tower for a direct-current line, contracted for construction this October. The agency also invited others to submit designs predicated on the use of two single conductors, with one overhead ground wire for lightning protection, and an anticipated spacing of 1,100 feet between towers. The tower for this line was thoroughly and successfully tested in Italy by world-renowned experts under the watchful eye of Bureau designers and engineers.

Design requirements of the towers were revised when engineers found that greater current-carrying capacity can be provided with the "bundle" conductor. Spacing the towers 50 feet further apart was also recommended to reduce the number of towers and, in turn, conserve time and money. All of these changes called for a stronger tower to support the added load.

In all but the southernmost areas, heavy winter storms form ice on transmission lines. The record shows that the added weight of ice has snapped insulators and damaged the tops of towers. However, through temporarily transmitting a controlled high current through the d-c conductors, they are warmed; this helps eliminate the problems of icing.

The final tower design for the first of four construction contracts for the 750,000-volt, direct-current line probably will be chosen from the three presently considered structures. These are: a self-supporting steel tower, a guyed aluminum tower, or a guyed steel tower. Selection of the tower for construction will be determined on the basis of comparable costs and construction time.

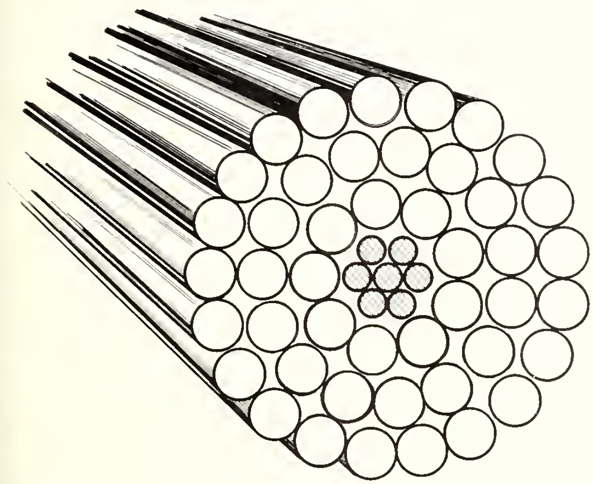
As work and construction progresses, the Bureau will employ its unique mobile electric test laboratory for performance testing. The completely equipped laboratory will prove invaluable in testing the performance of the electrical apparatus at any needed point of the Intertie. # # #

EMIL V. LINDSETH. Mr. Lindseth, Assistant Chief Engineer of the Bureau of Reclamation, is well known in the electrical engineering community for his contributions to advances in the technology of extra high voltage direct-current transmission of electric power. He has been in the Bureau since 1934 and has worked in structural design as well as in different phases of the engineering aspects of power marketing.

What's Watt *Notes*

A Bureau Triangular Tower

A flattened triangular (three-legged) tower has been adopted by Reclamation for the 94-mile section from the California-Oregon border to Round Mountain Substation. This span of the Pacific coast tie is 500-kv. The uncommon triangular design will result in a saving of steel without sacrificing strength.



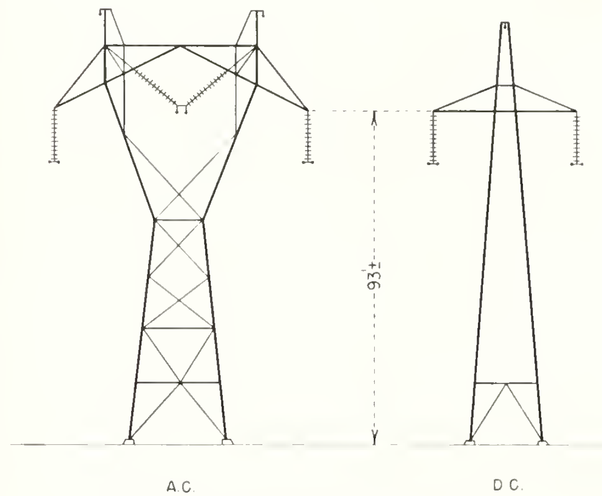
About Conductor Cable

Conductor cable for a 345-kilovolt a-c power system has seven strands of steel wire reinforcement in the center and a conductor covering of 45 strands of aluminum wire, as shown in the drawing above. The Hoover Dam-Phoenix line will be equipped with this type of cable.

The number of strands of both aluminum and steel vary with the amount of current to be carried. The above cable has a diameter of 1.2 inches, while a direct-current conductor is 2.3 inches across.

To Make Use of D-C

D-c power differs from common house current, but it is the same type as that from the automobile battery commonly having only about 12 volts. Making use of d-c in very high voltages (such as the 750,000 volts of the Intertie) involves two differences from the use of the small battery. The d-c must be transmitted to other points, and must be converted to alternating current. Both functions require precision use of several pieces of complex but essential equipment such as converters, rectifiers and transformers.



Comparing A-C and D-C Towers

A-C *500 kilovolts*		*D-C* *750 (±375) kilovolts*
85.6 feet	HEIGHT	84.6 feet.
64 feet	LENGTH OF CROSSARM	38 feet.
14.4 tons	WEIGHT	9.7 tons.

The Part Dams Will Play

Hydroelectric power from many powerplants located at dams in the West will be used during periods of peak use of electricity in the Pacific Northwest-Pacific Southwest Intertie area. Power from the Southwest will come partially from Reclamation's multipurpose dams, but mostly from the large thermal generating plants in California. Practically all of the transported Northwest power will be from hydroelectric plants, including the two at Reclamation's **Grand Coulee Dam.**

The principal hydroelectric suppliers at other locations will be Reclamation's **Hoover Dam, Shasta Dam, Trinity Dam, Hungry Horse Dam, Flaming Gorge Dam, Glen Canyon Dam, Curecanti Dam, Davis Dam,** and **Parker Dam.** Other main hydro suppliers will be **John Day Dam, The Dalles Dam,** and the Reclamation-operated **Folsom Dam.**

Continued on page 90

Direct current has not been commonly used to transport quantity or bulk electric current in the United States. This article presents the reasons for its use in the Pacific Intertie. Mr. Bennett also covers some aspects of alternating-current transmission, and briefly describes the Intertie.

A NEW ERA OF POWER TRANSMISSION

by N. B. BENNETT, JR.

THE Pacific Northwest-Pacific Southwest Intertie, linking two progressive, growing sections of the Nation, represents a most important achievement in the history of electrical development in the United States. It will place this country in a position of world leadership in the furtherance of transmission technology.

From the viewpoint of an engineer, it is an important milestone in the field of electrical development.

The aspect of the Intertie which lends it such significance in the eyes of engineers is its use of high-voltage direct current.

Direct current permits breaking the distance barrier in transmission, and like the modern turnpike for transportation, it makes possible the movement of large quantities of power for great distances at low cost. It opens the door to feasible

An artist's conception of a direct current tower designed by Reclamation is to support two pair of "bundle" conductors and two single overhead ground wires on the 575-mile line of the Intertie. Structural steel and cable requirements are less for direct current than for a-c.

power generation at remote and isolated localities, through efficient and economical bulk movement to wherever it is needed.

Direct current was used in the earliest transmission facilities carrying power from generating source to users, but was soon abandoned in favor of alternating current. The former received fresh impetus through use of high-voltage transmission in France near the turn of this century. Since World War II it has been used in Europe.

Here in the United States, however, only low-voltage, direct-current transmission has been used, and that in scattered operations. High-voltage d-c development has lagged, although, in general, American power systems are the most advanced in the world. Now, with the Intertie, rapid progress will doubtless be made in this field, triggering new and greater accomplishments in delivery of great quantities of electricity.

Direct-Current Economics

Direct current has some appreciable advantages over alternating current. It is more economical in both dollar costs and in the amount of power actually delivered to the user. For example, the dependable power-carrying ability of an a-c line is related to the volume of power carried, the size of the wire, and the length of the line. On lines as long as 300 miles, special and expensive equipment must be installed at intervals to maintain a dependable capacity, increasing the price tag of the system considerably. In the case of direct current, the length of the line has much less bearing on the dependable carrying capacity of the system, so it is possible to build and operate very long lines without any intermediate compensating stations or equipment.

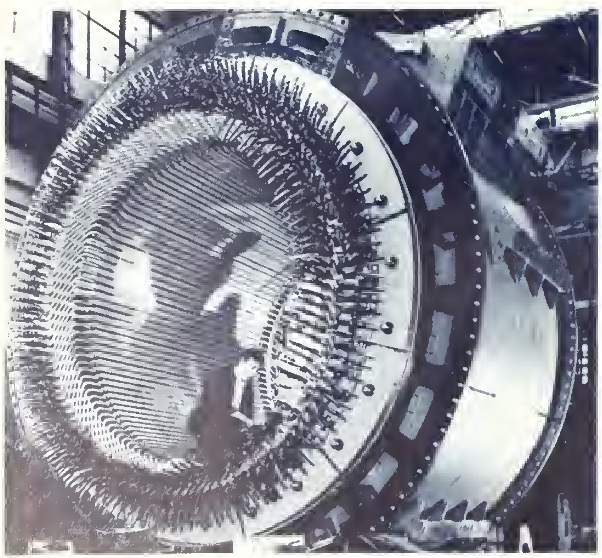
Considering these characteristics of the two types of transmission, a general rule of thumb is that with 900,000 kilowatts, d-c becomes more economical for distances greater than 500 miles.

Direct-current transmission requires costly terminal equipment to convert the alternating-current input into direct current for transmission and then back to a-c for integration into the receiving system. Hence, where the terminals are close together, its use for transmission is not economical. However, the long direct-current line is practical and economical. As its utilization increases, we may expected advances in manufacturing techniques, less expensive converter facilities, and overall decreases in future costs.

One interesting and very useful characteristic of d-c conversion and transmission has to do with a phenomenon known as system stability. Two large independent power systems, each internally stable, operating entirely on alternating current, cannot always be interconnected by the simple expedient of building a-c transmission lines between them. If this is done, the systems may upset each other and fail to operate in a synchronous fashion. As long as a power system is in electrical and mechanical balance within itself, it will continue to generate, transmit, transform and distribute power. It is said to have stability, and the protective devices such as breakers and switches are not in need of operating.

There are no stability problems when the systems are interconnected by converters and d-c transmission. The situation may be compared to two motors having different characteristics. If these two motors are connected by a stiff shaft and attempted to be operated together, the shaft will likely rupture. If, however, they are connected by fluid drive, they can be operated simultaneously without harm to the connection of either motor. With its similar flexibility, d-c should prove exceptionally helpful in interconnected operation. The two d-c lines of Pacific Intertie would require only two pair of converters, over 800 miles apart, to deliver power efficiently from generator to con-

A workman is assembling windings of a 100 MVA (1,000 volt amperes), hydrogen-cooled synchronous compensator. Compensators for the PNW—PSW Intertie will resemble this one. The one shown is manufactured by English Electric Co. for the 200-kv d-c scheme between Sardinia and the Italian mainland.



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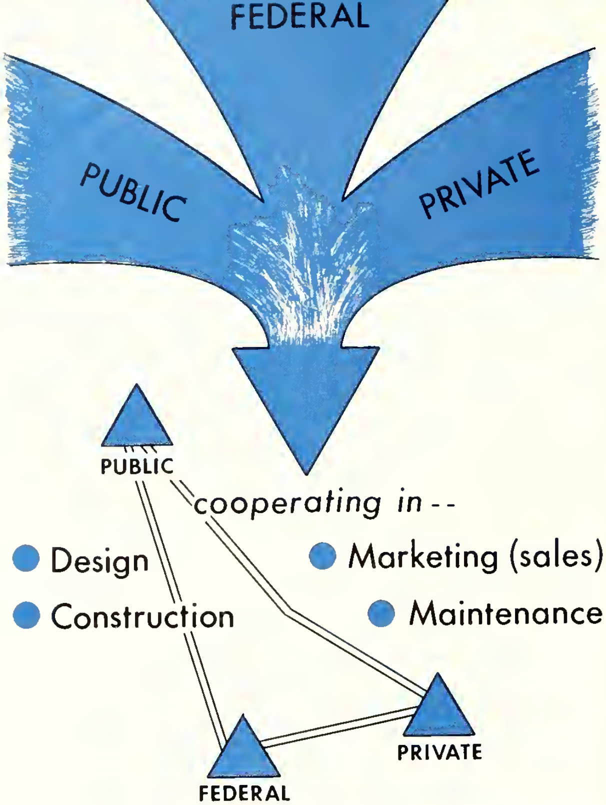


It is a significant accomplishment that Federal, public, and private groups cooperate in all phases of the Intertie including design, construction, marketing, and maintenance.

sumer, and each receiving system could continue to operate at its own pace, or without synchronization.

Conductor, Towers, Land

Among the other major economies resulting from use of direct current are lower costs for conductor, towers, and land acquisition for right-of-way. Direct current is conveyed by means of two conductors, as compared with three for a-c, thereby saving approximately one-third of these costs to carry the same amount of power. Less insulation is needed for d-c lines than for a-c. These factors result in two other economies: smaller towers and less land for right-of-way.

The efficiency of d-c for transmitting electric energy long distances is evident in statistics on losses. When the measurements are equal in the amount of power, the distance, size of conductor, and peak voltage, a-c line losses are about 33 percent greater than d-c line losses.

Also, a d-c line with two conductors, and its ground connection (electrode), will lose about one-half its transmission capacity, should one conductor become inoperative. On an a-c circuit, however, if one conductor breaks down, all transmission ceases. The fact that the earth can be used as a return conductor for the d-c line, whether permanently or temporarily, can be a great advantage.

There is, of course, some risk of damage to buried facilities in the area near the electrodes. Such risk can be minimized by normal corrosion prevention techniques, and by placing the electrodes in an isolated area. No comparable use can be made of the earth with a-c systems because of its undesirable influence on adjacent facilities, such as communication circuits. This is further explained in Mr. Lindseth's article on page 68.

The Pacific Northwest-Pacific Southwest Intertie will interconnect directly or indirectly the major Federal, public, and private electric systems in the 11 western States of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

The Intertie system will consist of four long extra-high-voltage lines and four lesser supporting lines, plus related terminal facilities. The two 750-kilovolt, (±375) kilovolt—(*See explanation on page 90*) direct-current lines will be the Nation's first and the world's longest high-voltage d-c lines. The Intertie also will include two long-distance, 500-kilovolt, alternating-current lines; a shorter 750-kilovolt, d-c tieline; two 345-kilovolt, a-c lines; and a shorter 230-kilovolt, a-c line.

From The Dalles

One of the 750-kilovolt, direct-current lines of 1,300,000-kilowatt capacity will be built from The Dalles Dam, Oregon, via Nevada, to Sylmar Substation near Los Angeles, a distance of 830 miles. The Oregon portion will be constructed by the Bonneville Power Administration and the Nevada-California section, by the city of Los Angeles.

Another 750-kilovolt, d-c line will stretch from The Dalles Dam, about 830 miles south, to Mead Substation near Hoover Dam, and will be connected to the Sylmar Substation by another 750-kilovolt, d-c line and to Liberty Substation near Phoenix, Arizona, by two 345-kilovolt, a-c lines.

Bonneville will build the northern section south to the Oregon border and the Bureau of Reclamation, the section from the border to Mead. The builder of a tieline between Hoover and the Sylmar Substation, or an equivalent California point had not yet been finally determined when the *Era* went to press.

One of the 500-kilovolt, a-c lines, with a 1 million-kilowatt capacity, will be constructed by BPA from the John Day Dam to the California-Oregon border, and by the Bureau of Reclamation, from the border to the Round Mountain Substation in California. From there, the California Power Pool will construct the line to the city of Los Angeles. In addition, the Bureau of Reclamation will string a short, connecting 230-kilovolt, a-c line, from Round Mountain to Cottonwood, 33 miles south.

The second 500-kilovolt, a-c line, also with a capacity of 1 million kilowatts, will be constructed from John Day Dam to Round Butte, Oregon, by the BPA. From that point to the California-Oregon border, the facility will be built by the Portland General Electric Company. The Pacific Power and Light Company will take it from the border to about 50 miles south, where it will connect with the California Power Pool—constructed line to Los Angeles via Round Mountain.

One Hoover-Phoenix 345-kilovolt line will be built by the Reclamation Bureau, another by the Arizona Public Service Company. Near Hoover Dam, suitable interconnection and terminal facilities for existing transmission lines as well as for the new 345-kilovolt, a-c and 750-kilovolt, d-c lines will be constructed. Mead Substation, located near the dam, will be the principal terminal installation.

Purpose

Purpose of the gigantic Intertie is to permit surplus Northwest secondary power to be sold in the Southwest and to make possible exchanges of Northwest summertime surplus peaking capacity for Southwest energy, with resultant substantial savings in powerplant investment in both regions. In addition, it will allow surplus Canadian Treaty Power to be sold in the Southwest.

Surplus Northwest secondary hydropower will be used to displace steam-generated power in California, and thermal power from the Southwest will be made available to "firm up" a portion of the Northwest's surplus energy. One result of the Intertie will be larger steam plants, since surplus from such an installation could be transmitted to the other region until the plant's full generation is required for loads in the plant's own area. Thus, the simultaneous building of high-cost, low-capacity steam plants in both areas can be avoided.

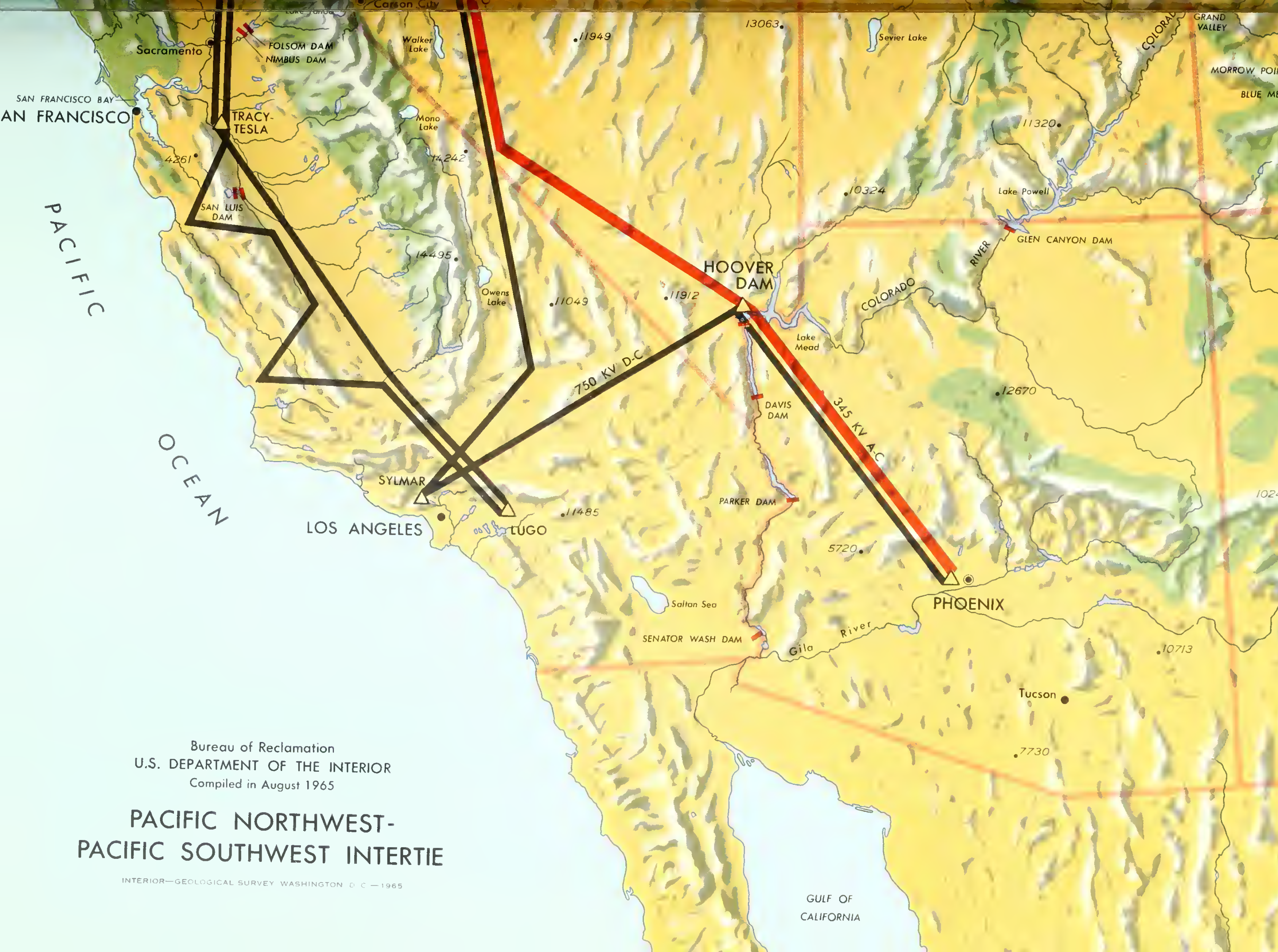
Studies show ample surplus power supplies in the Northwest and sufficient markets in the Southwest to fully load The Dalles-Hoover d-c line by 1978. It is scheduled to be completed in 1971, when 200,000 kilowatts will go on the line. The load is expected to increase to 600,000 kilowatts in 1972, to 900,000 in 1973, and to build up gradually to full capacity of 1,300,000 kilowatts by 1978.

As we develop this great electrical facility to utilize our power resources more fully, we can look into the future and see the Northwest-Southwest Intertie as the first section of a possible giant electric grid of private and public transmission turnpikes covering the entire Nation and bringing multiple blessings to every segment of the Great Society of tomorrow. # # #

NEWCOMB B. BENNETT. Mr. Bennett, Assistant Commissioner of Reclamation for engineering and power, is by profession a civil engineer. After a short tour with the Bureau in the 30's he engaged in private practice and served as Assistant State Engineer for Wyoming before returning to the Bureau in 1942. Having become a specialist in hydropower and the Bureau's activities in this area, in addition to general engineering, he was six years ago named to his present position as the chief administrative assistant to the Commissioner on power operations.

PACIFIC NORTHWEST-PACIFIC SOUTHWEST INTERTIE TRANSMISSION LINES


EXPLANATION
Substations and terminal points
Bureau of Reclamation line
Schematic
Other agency and utility lines
Schematic
Dams
Hydro-electric producers
Forest areas
14495
Spot elevations
1 INCH = 90 MILES
STRAIT OF GEORGIA
JUAN DE FUCA STRAIT
PUGET SOUND
Olympia
COLUMBIA
RIVER
10778
14410
12307
Lake Chelan
CHIEF JOSEPH DAM
GRAND COULEE DAM
ALBENI FALLS DAM
Priest Lake
ST MARY DAM
10448
HUNGRY HORSE DAM
Flathead Lake
10300
ROZA DAM
CHANDLER
Caeur d'Alene Lake
SNAKE
RIVER
ICE HARBOR DAM
CANYON FERRY DAM
BONNEVILLE DAM
MC NARY DAM
Portland
THE DALLES
JOHN DAY
11253
Salem
10033
11179
CLARK CANYON DAM
YELLOWTAIL DAM
HEART MOUNTAIN
SHOSHONE
Yellowstone Lake
BLACK CANYON DAM
Boise
BOISE DIVERSION DAM
ANDERSON RANCH DAM
12655
BOYSEN DAM
PILOT BUTTE
PALISADES DAM
500 KV A-C
500 KV A-C
Harney Lake
Malheur Lake
Crater Lake
Summer Lake
Lake Abert
9720
SNAKE
RIVER
MINIDOKA DAM
AMERICAN FALLS DAM
11363
9510
GREEN SPRINGS
Goose Lake
10340
FONTENELLE DAM
FREMONT CA
KORTE
SEMINO
14162
SHASTA DAM
TRINITY DAM
500 KV A-C
Bear Lake
LEWISTON
CLEAR CREEK
WHISKEYTOWN DAM
SPRING CREEK DAM
KESWICK DAM
COTTONWOOD
ROUND MOUNTAIN
Eagle Lake
10466
Haney Lake
Lake Almanor
Winnemucca Lake
Pyramid Lake
750 K
Great Salt Lake
GATEWAY
Salt Lake City
WANSHIP DAM
DEER CREEK DAM
FLAMING GORGE DAM
13498
11349
Franklin Lake



Bureau of Reclamation
U.S. DEPARTMENT OF THE INTERIOR
Compiled in August 1965

PACIFIC NORTHWEST-PACIFIC SOUTHWEST INTERTIE

INTERIOR—GEOLOGICAL SURVEY WASHINGTON D. C.—1965

Every power transmission line is custom made and requires something new and different. The engineer and a team of other specialists have to solve many problems as they come to them. This article tells about a few of the Intertie's entirely new characteristics and problems that will be encountered and solved.

It can be DONE

by BERNARD P. BELLPORT

WHEN Congress gave the green light for the Pacific Northwest-Pacific Southwest Intertie, Reclamation launched extensive design and construction programs. Seven other cooperating power agencies—public, Federal and private—put their Intertie programs in motion, too.

The job for the engineer is huge and challenging. The PNW-PSW Intertie will be the longest power system in the world; it will be big or biggest in various other ways. And it is on its way. For the Bureau of Reclamation, plans call for construction of three sections of extra-high-voltage-transmission lines, one section being our Nation's first such direct-current line.

Other real challenges are meeting dates for interconnecting with the lines of partner agencies, as well as the actual completion and operation of the various units, not to mention new designing for the direct-current terminals.

For over 5 decades, the Bureau has been engineering and building alternating-current transmission facilities, including 12,000 miles of lines ranging up to 345,000 volts. With Reclamation's experience, it is prepared to engineer and construct, effectively and economically, a 575-mile-long, 750,000-volt, direct-current line; a 95-mile, 500,000-volt, alternating-current line; and a 240-mile, 345,000-volt, alternating-current line.

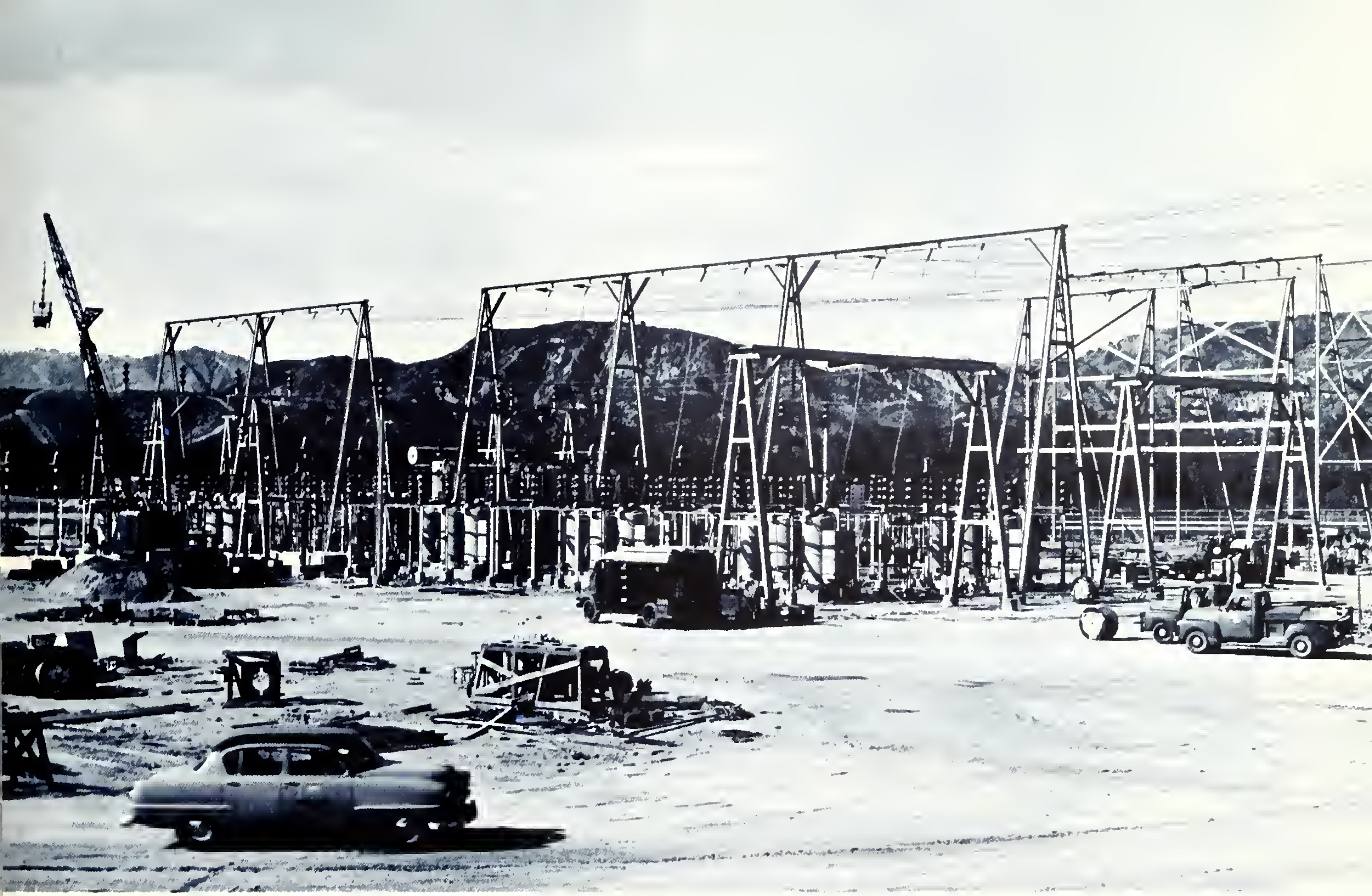
These new lines required the design and construction of special towers. And complex testing substations were designed to meter electric current, to convert current (a-c to d-c and d-c to a-c), and to switch the power to other transmission lines for delivery to the consumer.

To locate the lines, routes were surveyed and aerial photographs made of the topography. Careful field and geologic investigations are in progress for the land rights-of-way and for locating individual tower sites.

A total of approximately 4,410 towers will be required to complete the Bureau's four transmission lines, covering nearly 950 miles.

First major work by the Bureau has already begun on the 95-mile line from the Oregon-California border to the Round Mountain Substation in California. This line, scheduled for completion in December 1966, features entirely new tower designs. Like most such large transmission towers, they will be made of steel and will vary in height, some reaching as high as a 16-story building, 162.5 feet. A total of 4,750 tons of steel will go into the construction of these towers, enough metal to build 3,200 medium-sized American automobiles.

The conductors will consist of a bundle of 1.6-inch diameter cables spaced 18 inches apart. These bundle conductors will be strung below 27 porcelain insulators allowing a minimum clearance of 35 feet over uncultivated land, and 40 feet over cultivated land, roadways, etc.



From the Sylmar terminal facility shown here under construction, power will be conveyed to users in the Metropolitan area of Los Angeles and throughout the Southwest. (Los Angeles Water & Power photo).

Rugged Topography

Aerial photographs of rights-of-way reveal dense forests which will require extensive clearing and road-making for nearly the entire length. The construction also will involve proper clearance of existing roads, railroads, rivers and towns.

The route of this Bureau line is alongside that of another intertie line. Both are constructed under a cooperative agreement with the Pacific Gas and Electric Company. The centers of the two lines will be 150 feet apart on a 350-foot-wide strip.

The surveying and exact plotting of the location for each individual tower are followed by an analysis of the earth materials to verify a strong foundational support for the steel structures.

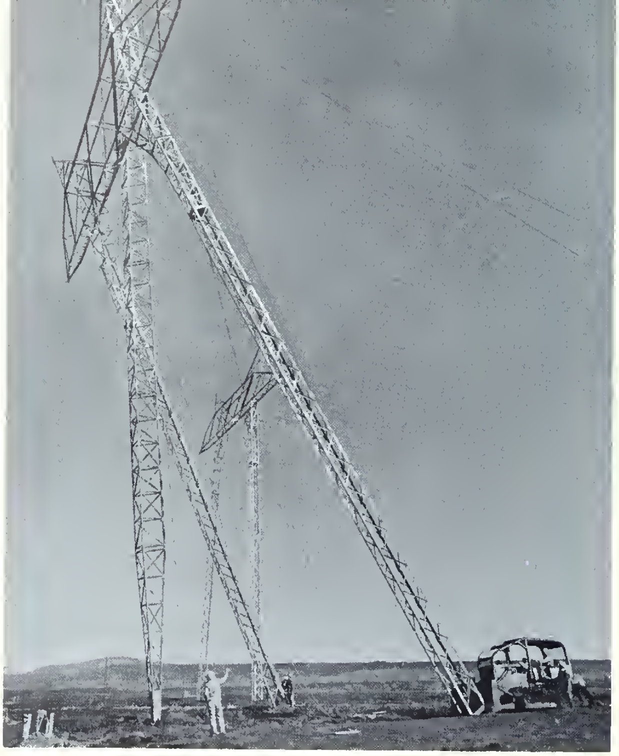
Elevations of the right-of-way vary from 2,200 to 5,000 feet, with an average of about 4,300 feet.

Designing has taken into account all weight and stress problems: icing on the lines, wind loads, geologic conditions in the foundation areas, rock-slide areas, seasonal flashflooding, passage over other smaller transmission lines, clearance over planned future roads, and numerous other contingencies.

In about September, the Bureau will issue contract specifications on a 230,000-volt transmission line from Round Mountain to the Cottonwood Substation, 33 miles away. This line will tie together the extensive facilities of the Central Valley Project and the Columbia River Power System. It will cross about 16 miles of heavily wooded, mountainous terrain at an elevation of 2,200 feet at Round Mountain, descending to approximately 420 feet at Cottonwood.

This relatively short section will cross three highways, the Sacramento River, one railroad, a 230,000-volt transmission line, and several small creeks and streams subject to intermittent high waterflows. Approximately 160 towers will be included in this tap line, to carry the three single conductors.

By far the largest phase of the Bureau's construction program involves the Oregon Border-Mead Substation 750,000-volt, direct-current trans-



Using the gin pole tower technique, the Pacific Gas & Electric Co. force's schedule calls for erecting an average of seven towers a day during 1965 and 1966. (P.G. & E. photo).

Guyed towers of P.G. & E.'s 500-kv a-c system are already in place near Round Mountain, Calif.—a segment of the Pacific Northwest-Pacific Southwest Intertie. (P.G. & E. photo).

mission conveyance. This entire 575-mile-long line is to be completed in January 1971.

Final specifications on the design of the towers are still being drawn up. However, the preliminary location of the line has been made, calling for the construction of approximately 2,650 towers extending across nearly the entire north-south length of the State of Nevada. Contracts have been awarded for the first one million feet of conductor for this line.

Even the detailed aerial and ground surveying for this unusual development are being conducted under four separate contracts. The areas crossed include open desert, lava beds, desolate rock ranges, and forested mountains.

Examinations have resulted in some minor relocation to satisfy tower safety. One of the most serious of these problems would be placing installations at sites near banks of large stream channels which might be undercut or eroded by flash-flooding. Some tower reloctaions also were influenced by nearby steep slopes where large boulders may dislodge and strike the structures. Other potential hazards considered are areas of possible snowslides, landslides, swampy conditions, high water tables, and possible extreme land settling.

Larger Hoover Facility

The specialized equipment making up the four direct-current terminals of the Intertie constitutes the system's heart. One of these terminals will be located at Hoover's Mead Substation. The exploratory drilling into the earth, necessary prior to construction, was completed several months ago.

Although there are many large electric power headquarters in this country, the one at Hoover Dam will be one of the most unusual when the Intertie becomes established there. Hoover Powerplant's 1,344,800 kilowatts already are distributed through a huge substation. But by 1971 a direct current terminal at Mead Substation will include alternating-current facilities such as transformers, lightning arresters, circuit breakers, and other equipment.

The critical direct-current components in the Mead Substation terminal are the converter valves. These valves convert the alternating current at the originating end of the transmission line to direct current. At the receiving end of the line, these same rectifiers work in reverse direction, converting the direct current back to alternating current for use by the consumer.

In April a contract was awarded to General Electric, and a Swedish firm (Allmanna Svenska Electriska Aktiebolaget, ASEA) to build two terminals, the first high-voltage direct-current terminals ever to be installed in the United States. The first terminal at The Dalles, Oregon, scheduled for operation in 1969, will employ 133-kilovolt valves. Six of these valves in series will be required to accomplish the total line voltage of 750 to 800 kilovolts.

For the Mead terminal at Hoover Dam, Nevada, scheduled for operation in 1971, the contractor offered 200-kilovolt valves, the largest and most powerful ever built.

Because each of the terminals must perform compatibly with each other, they are extremely technical in nature. A committee of special Intertie representatives is negotiating with contractors to obtain the exacting equipment.

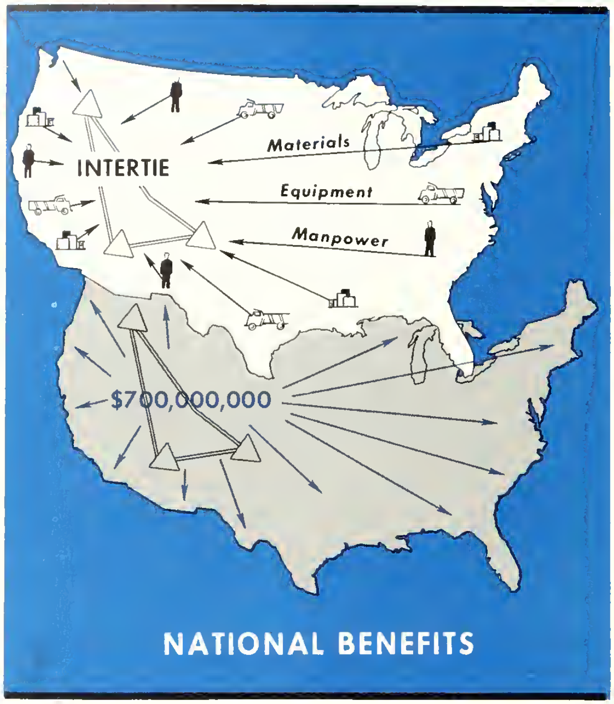
The Mead Substation will serve as a terminus for the new 345,000-volt alternating-current line being built by the Bureau to serve the Phoenix, Arizona area. This phase of the Intertie is scheduled for completion in 1967.

Bureau construction on the Pacific Northwest-Pacific Southwest Intertie is well on its way, and a challenge in the history of electric power transmission is being met. # # #

BERNARD P. BELLPORT. Mr. Bellport is Chief Engineer of the Bureau of Reclamation and as such heads one of the world's leading engineering centers, the Bureau's Denver facility. He has been with the Bureau for nearly 30 years and has been closely associated with construction of its powerplants and power distribution systems, as well as with research in the electric energy field, which is carried on at the Bureau Research Center in Denver.

This drawing shows the amount of steel—4,750 tons—needed in the towers which carry 500-kv a-c cables for 95 miles, the distance from the Oregon-California border to Round Mountain Substation in California.

The straight deforested strip in this aerial photograph shows the right of way in Northern California for the 500-kv line.



This article describes how the PNW-PSW Intertie will benefit some of the key elements of the U.S. community, and will bring more values by its construction.
We think you'll agree that . . .

ITS BENEFITS ARE BIG!

by WILLIAM H. KEATING

When the sun glances off the snow and ice of Western mountain peaks, it is a flashing gleam with prophetic meaning to the observer miles away. Sparkling rivulets run away from the melting snow and ice, and join each other at lower elevations where people build communities.

Before man lets the precious water pass in rivers to the ocean, he does his best to make multiple use of it. He enjoys its fresh beauty, gets nourishment from it, and uses it to generate electricity, to light his buildings, and turn the wheels of his industries.

It was not by candlelight, nor by power from the lowly storage battery that man has supplied the needs of crowded cities, of the farmer, or of the high production of modern industry. Most modern power generation is from plants which utilize jets of steam, or plants which harness tons of falling water. The billions of kilowatts of energy these plants produce, and the highly developed metal cable that transports the energy, are mainly responsible for our progressive standard of living.

The world's most advanced carrier of such bulk electric current, soon to be a reality, is the Pacific Northwest-Pacific Southwest Intertie, which is described in other articles in this issue of the *Reclamation Era.*

The benefits to be derived from this massive interstate grid will exceed the cost of the facilities by a ratio of 2.5 to 1. But some benefits are so far-reaching as to be almost incalculable.

The Federal investment will be $294 million out of a total of $697 million invested. Over a 50-year amortization period, the development will produce benefits of at least $2.6 billion, of which two-thirds will accrue to electric utility preference customers in 11 Western States.

Geographically, direct dollar benefits will be divided as follows: the Pacific Northwest, $1 billion; California, $869 million; and Arizona and Nevada, $724 million.

Although the above returns, in such great amounts, are bound to bolster the economy, the project will also create thousands of jobs throughout the country. An estimated 10,000 man-years of direct employment at or near the job sites will be required for erecting towers and conductors and for related construction. This is the equivalent of a city of 10,000 workers all working an entire year on the Intertie. Another 30,000 man-years will be required in the Nation's factories to produce the materials for the lines and terminal equipment.

The four major lines will require about 118,000 tons of cable of the aluminum conductor, steel reinforced type. Preliminary estimates for the towers indicate a requirement for 230,000 tons of steel, if only steel towers are used, or 47,000 tons of aluminum plus 110,000 tons of steel, if both kinds of towers are used. Obtaining these materials will involve some $350 million in contracts with large manufacturers in different parts of the Nation. Another $240 million will be spent for converter equipment, transformers, series capacitors, circuit breakers, and communications equipment.

The Pacific coast area has been supplying about 59 percent of all the softwood lumber produced in the United States and virtually all of the softwood plywood.

The first direct current terminals ever to be installed in the U.S. will cost about $52 million and will be furnished by a contract awarded last April to an American firm, General Electric Company, working cooperatively with a well-known Swedish Company.

From Small Manufacturers

The Intertie also will require, from small manufacturers, vast amounts of porcelain for insulators, concrete for foundations, and copper for switches. They also will supply many wiring devices, relays, instruments, switchgear, transformers and other items.

Of the proposals submitted to construct all or portions of the Intertie, those of seven non-Federal agencies were selected and will share in construction, financing, and operation of the lines.

Starting in 1967, Intertie power generated by Federal powerplants will be needed at pumping plants for irrigation, municipal and industrial water supply in California. Without the Intertie, preference customers now using this power would face a dwindling supply of electricity which could only be replaced at much higher costs.

The principal way the irrigation farmer will be aided by the coming of the Intertie is the greater abundance of electric power, permitting more efficient utilization of his irrigation systems that are, or may be, operated by electric pumping. It also appears likely that the present cost to irrigators who may be using power sources other than electricity could be lowered by converting to electricity, when the abundant, low cost supply is available.

With the greater availability and growing use of electricity by the farmer in the West, the Department of Agriculture reports that irrigation pumps use more electric energy than any other farm motor. In 1950 there were 156 thousand irrigation pumps in 19 Western States and Florida. Electric motors provided power for 67.3 percent of them. Since that time, 28 thousand pump installations, of which 5 thousand were electric, were made in the Texas panhandle.

In the Pacific Northwest, water which otherwise could be put through turbines to create low-cost power is spilled into the Pacific Ocean in the summer for lack of markets. However, in the winter, power demands often soar to one million kilowatts in eight hours.

Conversely, in the Pacific Southwest, power demand in the summer frequently increases by one million kilowatts in a few hours—taxing steam plants which principally burn natural gas, a high-value, nonrenewable natural resource. Yet, in the winter these plants are not operated at full capacity and lie partially idle.

In both instances, there is waste of natural resources and capital investment.

The Intertie will provide a practical pattern for effective and efficient utilization of our country's power resources, as envisioned in the Federal Power Commission's National Power Survey.

In the Northwest, the Intertie will increase Bonneville Power Administration's net revenues by as much as $20 million annually and by $11 to $12 million on the average over 50 years—thus helping to keep BPA's rates lower than otherwise possible.

Just preceding construction of the northern reaches of the Intertie, 700 to 900 miles of rights-of-way will be cleared by lumber contractors, the job will be of a magnitude equal to the most ambitious in lumbering history. The total amount of timber to be removed will be extremely large in Oregon and very sizable in California. Lumbering is already underway on one section of the line in California.

Most of the forested routes in both states are in rugged mountain terrain, which will be difficult for lumbermen to traverse, but that's part of his work and the resulting benefits will be worthwhile.

Roads and Trails

There never again can be an Oregon trail like the *Oregon Trail* of pioneer heritage, but there will be an Intertie venture of modern trail building through steep, defiant terrain.

230,000 tons of steel, if only steel towers are used, will be required in towers for the four major lines, or 110,000 tons of steel if both steel and aluminum towers are used. (U.S. Steel photo)

Local Electric Public Agencies With Direct Dollar Benefits

State	Rural cooperatives	Other public agencies
Arizona	9	23
California	1	32
Idaho	17	8
Montana	4	----------
Nevada	1	3
Oregon	17	14
Washington	11	31
Total	60	111

Local Electric Public Agencies to Receive Increased Power Supply

State	Rural cooperatives	Other public agencies
Arizona	----------	1
Colorado	2	18
New Mexico	2	5
Utah	5	37
Wyoming	1	6
Total	10	67

Some rough graded trails and roads on which surveyors and line builders will travel will be scraped out of desert. On the other extreme, some roads will cut through low forest valleys and high mountain saddles at 5,000 or 6,000 feet elevations, providing awesome scenic views. Scores of the new back-country roads will end at the tieline site and never be used again, but many, no doubt, will be used in powerline maintenance.

Some Intertie vehicle trails will be valued by the forest manager in his efforts to protect good trees, salvage dead ones and grow new ones. According to the U.S. Forest Service, basic access road systems in northern California have been only half completed; in Oregon, one-third are inadequate for use.

The Interties roads in at least those two states will be utilized by the sportsman for hunting and fishing—and by the many who enjoy a picnic in the forest.

For years the Federal hydroelectric program and the anti-monopoly clause in Federal law have buttressed and supported the small local community that wished to own its own electric system, or the farm community that organized a rural elec-

tric cooperative to serve its widely scattered member-owners with reasonably priced electric power.

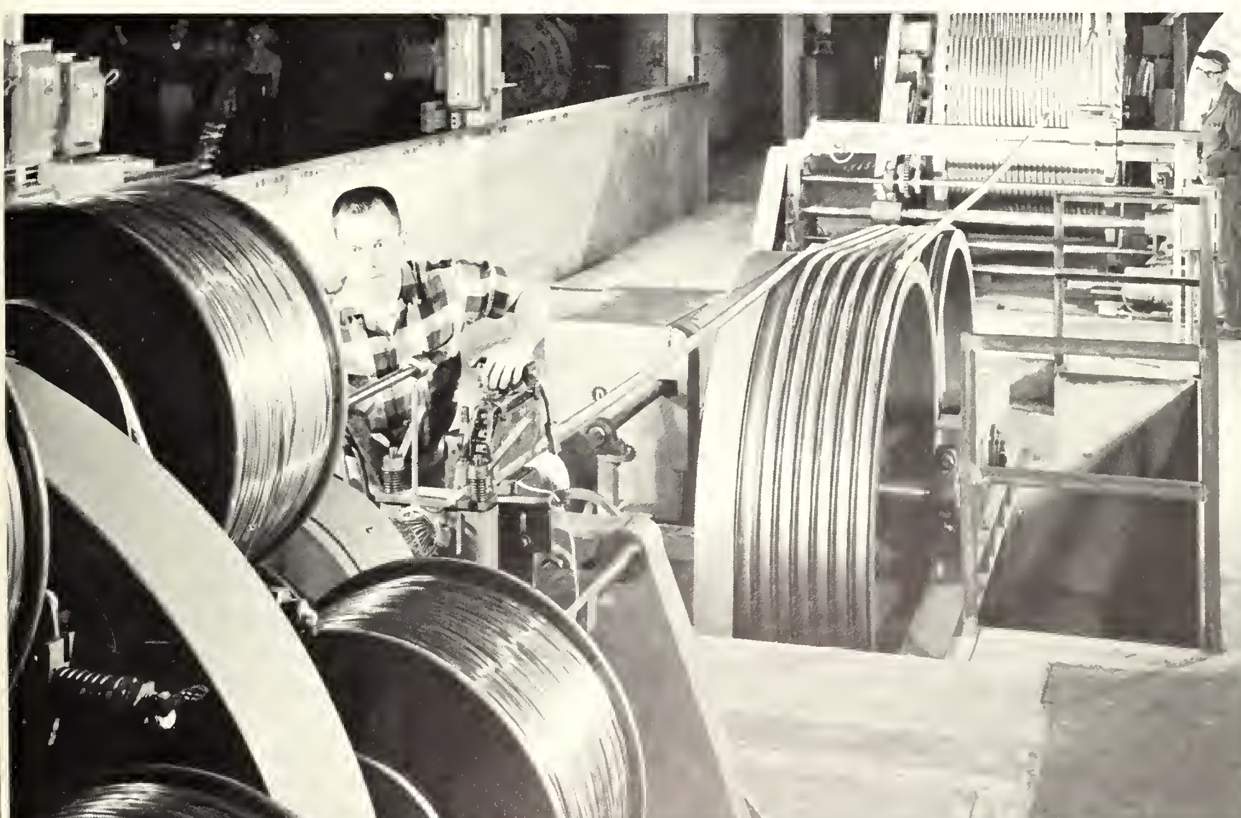
In regard to the benefits and funds for repaying construction costs of various water resource developments, it has been the marketing of hydroelectric power that has made recent Reclamation projects possible.

The Pacific Northwest-Pacific Southwest Intertie, as approved by President Johnson, the Congress and Secretary Udall, will result in more benefits to more public agencies in more States than any other single intertie proposal submitted to the Department of the Interior. Most important of all, it will provide untold benefits for the public and will bolster the economy of the most progressive section of the Nation—the West. # # #

WILLIAM H. KEATING. Mr. Keating, chief of the Bureau of Reclamation's power division, has been identified with electric power operations during practically his entire 15 years of service in the Bureau. An electrical engineer, he was assistant regional supervisor of power in Region 2, headquartered in Sacramento, California, before assuming his present post in Washington, D.C.

The Intertie rights-of-way are cleared of logs like this 32-foot Ponderosa pine.

This machine is stranding aluminum wire into high-voltage electrical cable. The four major Intertie lines will require about 118,000 tons of cable of the aluminum conductor steel reinforced type. (Reynolds Metals Co. photo)



There were early experiments during the 19th century in direct-current electricity in this country as well as across the Atlantic. However, for experience in major transmission of d-c, we have turned to Europe and learned from the progress made there.

D-C Developments in Other Countries

by T. W. MERMEL

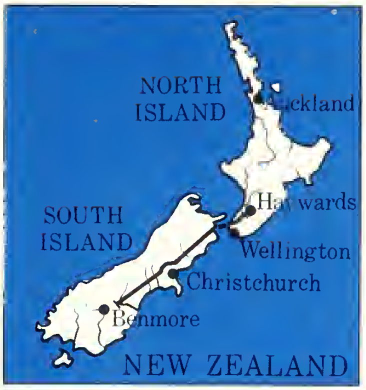
THE debate on the merits of direct-current electricity, as opposed to alternating current, has been going on since the 1880's when Thomas Edison pioneered on a direct-current system of distribution.

Early Results. After Edison, came a definite shift to a-c when the French engineers, Gaulard and Gibbs, invented the a-c transformer. This permitted the voltage of a-c to be changed to any desired value, and made electric transmission voltages independent of generator voltages. Never-the-less, the d-c advocates continued their work, and in France, Marcel Deprez pursued the study and use of direct current and actually built a 2-kilovolt d-c transmission line 25 miles long. This line used iron telegraph wire. By 1886 he had built a 6-kilovolt direct-current line which transmitted power 35 miles.

Work continued in Italy and Switzerland, with Rene Thury building d-c systems, some as long as 35 miles at voltages as high as 27 kilovolts. Generators were placed in series on insulated bed plates and, when lines failed, ground return was used. By 1905 Thury had a 57-kilovolt d-c system 112 miles long from Moutiere to Lyon, France. In England, J. S. Highfield adapted a d-c system in the London area and placed the two 100,000-volt transmission cables underground so as to preserve the attractiveness of the landscape.

At the same time, credit for transmission technology accrued to the United States when F. C. Hewitt successfully converted a-c to d-c by means of the mercury rectifier (converter). Further development of this type of rectifier was made by the General Electric Company in 1905, and was used by that company in a street lighting development in the State of New York until 20 years ago. It also is significant that before World War II, General Electric Company had experimented with 25-kilovolt line using the mercury rectifier.

Continuing with higher voltages of direct current in Europe, Switzerland made some early ex



perimental advances in the field, and Germany built a 100-kilovolt experimental line in the 1930's to carry 15 megawatts for 3 miles between Moabit and Charlottenburg.

Germany. During the second World War, despite the proximity of battle, German researchers were building an experimental 400-kilovolt system to transmit 60 megawatts for the 75 miles from the Marenfeld terminal in the city of Berlin to a terminal at the Elbe power station. The system consisted of a 2-cable, 440-kilovolt line (±220 kv).—(*Term is explained in Note on page 90.*) This is the same principle that will be applied in construction of our Pacific Northwest-Pacific Southwest Intertie, though the 750-kilovolt Intertie capability is considerably greater.

Following the war, the researchers were dispersed, the equipment removed and further research in Germany was discontinued.

Seeking Solutions

According to reports, the German efforts in this field were motivated primarily by limitations on the load-carrying capacity of overhead transmission lines requiring many circuits and rights-of-way through heavily industrialized centers. They were seeking a solution to the long-distance transmission problem and were interested in d-c because underground cables could be used. A 1942 German report outlined four interesting advantages of underground cables over transmission circuits carried on towers, as noted:

"1. Cable is safe from atmospheric disturbances, such as storms, ice, rain, and lightning.

"2. Cable can be laid in places where there is little space; e.g., in mountains, main city streets, and in buildings.

"3. Cable is laid underground and, therefore is not visible; thereby planned attacks from the air and through sabotage are hindered; the landscape is not disfigured for the same reason.

"4. Cable does not interfere with air traffic or telephone circuits."

These same statements could be made just as well today.

After World War II, advances in high-voltage alternating-current technology pushed aside further work on d-c systems, although the advantages still were recognized by engineers.

Sweden. In Sweden, research resulted as early as 1929 in patents by ASEA (Allmanna Svenska Elektriska Aktiebolaget), and was further pursued under the leadership of Dr. Uno Lamm, which culminated in a decision to deliver power by d-c to Gotland in the Baltic Sea some 70 miles off the coast of Sweden. In 1954, a single direct-current 100-kilovolt underwater cable was used to deliver about 20 megawatts. Ground return was by sea. The successful application at Gotland Is-

(From top, left to right). France and England are connected by a double circuit, direct-current line, running 32 miles under the English Channel. *Sweden and Denmark send kilowatts back and forth over 112 miles of high-voltage direct-current line that lies undersea for 47 miles. *Gotland Island receives power from the Swedish mainland 70 miles away by direct-current underwater cable with an earth (sea) return. *Sixty-one miles of undersea cable is included in the 278 miles of direct-current lines transmitting power from LaSpezio on the Italian mainland to Sassari on Sardinia. *A 35-mile-long high-voltage direct-current transmission line conveys power back and forth between the two New Zealand Islands, utilizing 25 miles of submarine cable. *Having a different need, Japan uses direct current in a back-to-back frequency changer (no transmission line is used to connect converters) that has a potential force of 430 kilovolts. *In 1967 Vancouver and Vancouver Island, Canada, will be linked by d-c between Stratford Terminal Station, Arnott and Newton Station.

Renowned engineer in direct current technology, Dr. Uno Lamm, right, Electrotechnical Director of ASEA, Sweden, escorts an American study-team through his manufacturing firm. Shown making the 1963 visit are, from left, author Mermel; Paul E. Shad, General Manager and Chief Engineer of the Sacramento Municipal Utilities District; and Charles F. Luce, Bonneville Power Administrator.

land revitalized potential applications of d-c transmission.

France-England. In 1961, using Dr. Lamm's system (ASEA), a submarine cable connection was made across the English Channel between the 225-kilovolt a-c system at Echinghen, France, and the 275-kilovolt a-c system at Lydd, England. Two single-core cables make this 40-mile span, transferring 160 megawatts of power each operating at 100 kilovolts, one positively charged and the other negative. Ground return can be used in case one cable is damaged, thereby carrying one-half of the power in an emergency.

U.S.S.R. In the U.S.S.R. an experimental line has been built from Moscow to Kashira.

This is an underground single-core cable operating at 100 kilovolts with ground return. Based on the research connected with this project, the Russians developed their d-c technology and mercury-arc converter valves, and subsequently added an overhead return to boost the capacity to 200,000 volts. This work led to their decision to build a 294-mile full-scale system from Volgograd to Donbass. Reports have been received that the first operation of this line on steel towers at 800 kilovolts was made in November 1964 and that it is able to carry 750 megawatts. Earlier operation was at reduced voltage.

Longer Distances

Russia's interest in long d-c transmission lines stems from the fact that many of its huge hydro-plants are located great distances from load centers. The Soviets are doing research on plans to construct a 1,400-kilovolt d-c line to carry power more than 1,000 miles.

New Zealand. In New Zealand, a 500-kilovolt d-c system is under construction which will extend 385 miles from Benmore on South Island to Haywards, a southern point of North Island. An underwater portion of this development will cross the 25-mile Cook Strait.

Sardinia-Italy. In Italy, a 200-megawatt transmission system is under construction which will extend from Sassari on the Island of Sardinia, across Corsica, and connect with the Italian mainland at LaSpezia. The system will operate at 200 kilovolts with ground (sea) return. Two submarine cables will be installed which can be operated in parallel, or one cable can be used as a spare. English Electric Company is supplying the converter stations, using Swedish ASEA equipment for the system, which will be submarine for about 61 miles and overhead across land. It is scheduled for operation in late 1965.

Japan. In Japan, d-c transmission is being adopted to interconnect two a-c power systems of different frequencies, one operating at 50 cycles and the other at 60 cycles. The link, referred to as a back-to-back system, will be situated entirely within a converter station at Sakuma and will be in operation this year. It permits a nonsynchronous connection of high efficiency between two systems and removes many of the stability problems.

Sweden-Denmark. A Sweden-Denmark link, which was talked about as early as 1913, is now underway. It is known as the Konti-Skan Project (Kontinent-Skandinavia), and was planned for completion by the summer of 1965. This 105-mile-long single-cable will provide a link between a 400-kilovolt a-c system in Gothenburg, Sweden, and a 150-kilovolt a-c system in Alborg, Denmark. During the first few years, the link will be used to export surplus power from Sweden. The converter stations at both ends also are being supplied by ASEA of Sweden.

Canada. A d-c link between Stratford on the Island of Vancouver and Arnott on the mainland will be made by 17 miles of submarine cable and 26 miles of overhead lines to be in operation by 1967.

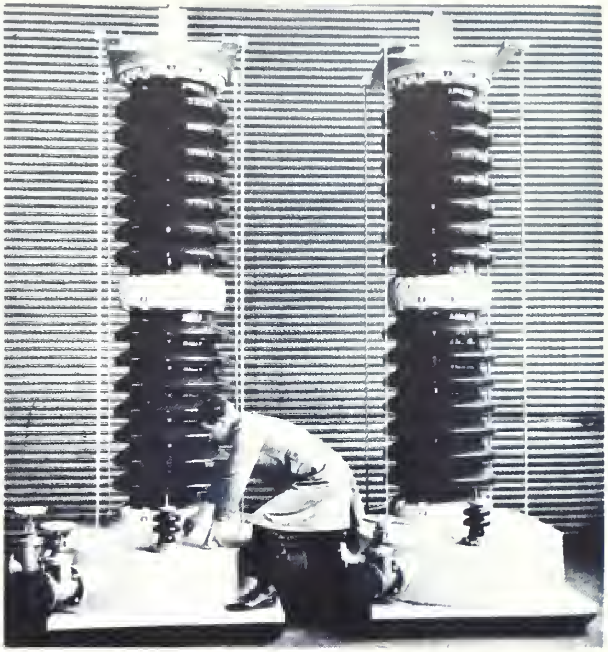
London. A 500-kilovolt d-c London cable is planned to provide a link between a new 2,00(

megawatt generating station on the Thames River and two substations on the 132,000-volt a-c transmission system within the London area. It will involve a 250,000-volt underground cable carrying 250 megawatts for 37 miles to a point where it will be tapped. The cable will then continue for another 16 miles to a 132-kilovolt substation located on the south London network.

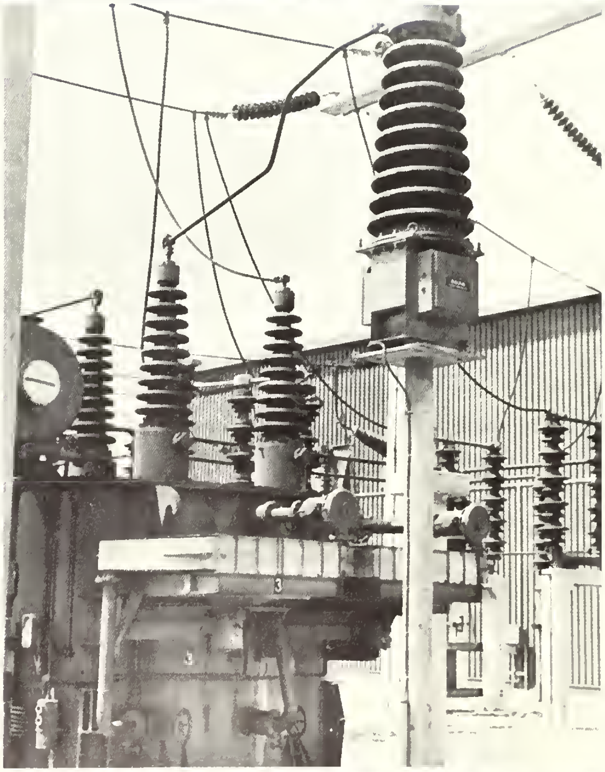
The experience gained from this operation will demonstrate that high-voltage direct-current interconnections have other important applications, even though a few years ago it was thought that d-c would be used purely for long-distance bulk transport of power. While alternating-current was studied for this application, it was not entirely satisfactory because it introduced many system stability problems not associated with a d-c system. Another advantage is that the transmission capacity of a d-c cable is twice that of an a-c cable of equivalent size and voltage.

Many other proposals for d-c systems are under discussion. Growth and experience in the field have been phenomenal. From 1955 to 1965, direct-current systems expanded from 20 megawatts to more than 1,500 megawatts (including United States, but excluding the Russian projects). This figure will double in the next 6 years. # # #

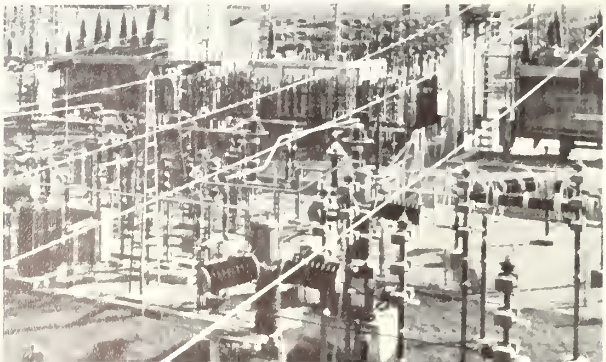
THADDEUS W. MERMEL. With the Bureau of Reclamation for more than 30 years, T. W. (Ted) Mermel, an electrical engineer, participated in the preparation of designs and studies for the epoch-making Hoover and Grand Coulee Dam powerplants in the 30's and 40's. Today he is Assistant to the Commissioner for Research, and also Chief of the Bureau's General Engineering Division.



This equipment is for protecting and controlling electric current for an a-c harmonic filter in a d-c transmission scheme. They are oil cooled resistors for a 55 MVA (1,000-volt amperes), 230-kv harmonic filter.



Used to measure current is the pole-mounted device in the foreground—a European-made direct current transductor.



This European a-c–d-c switchyard and terminal was studied by Bureau engineers before designing and starting construction on the Pacific Intertie. (ASEA Electric photo)

"*What's* Watt *Notes*" *Continued from page 71*

Major World D-C Installations

System	Year of service	Kilovolts (thousands of volts)	Power in megawatts (mw.) (millions of watts)	Length in miles	Remarks
Moutiers-Lyon, France	1905	57	4	112	Overhead cable.
Mechanicville-Schenectady, U.S.A.	1936	27	5	17	Do.
Moabit-Charlottenburg, Germany	1940	100	15	3	Do.
Moscow-Kashira, U.S.S.R	1950	200	30	70	Underground and overhead cable.
Sweden-Gotland	1954	100	20	70	Earth (sea) return.
English Channel	1961	200	160	41	Double circuit, 32-mile undersea cable.
Volgograd-Donets, U.S.S.R	1964	800	750	294	All overhead.
Sweden-Denmark	1965	250	250	105	47-mile undersea cable.
Haywards-Benmore, N.Z.	1965	500	600	385	25-mile undersea cable.
Sakuma, Japan	1965	430	300	0	Back-to-back frequency changer.
Italian Mainland-Sardinia	1965	200	200	278	Double circuit, 61-mile undersea cable.
Vancouver-Vancouver Island, Canada.	1967	*260	*310	43	17-mile undersea cable.
The Dalles-Los Angeles, U.S.A.	1968	750	1350	827	
The Dalles-Hoover, U.S.A.	1971	750	1350	830	
Los Angeles-Hoover, U.S.A.		750		270	Capacity to be determined.
London-Thames, England		500	500	53	Proposed underground.

*Ultimate, initial stage 130-kilovolt, 78 megawatts.

Note on (±375) KILOVOLTS—

A d-c transmission circuit usually consists of two cables; the voltage of one cable being 375 kilovolts BELOW a voltage median (median is zero or "ground"), and the other cable being 375 kilovolts ABOVE the median. This results in a total voltage of 750 kilovolts, as in the PNW-PSW Intertie.

Insulators for High Voltage Lines

Before individual insulators are adjoined together and attached in a string near the top of a tower, their bell-like shape is evident. Ten inches across the bottom width is a standard size insulator for a 345-kilovolt power line as well as some other high voltage lines. One insulator costs about $3.50 and will support a load of more than 10 tons. Twenty units complete a normal sized string. The alternating current tower with three single strings totals 60. *(photo below shows 230 k-v insulators)*

In the construction of this tower, notice the high position of th[e] four workmen. This is not an Intertie tower.

Power Officials Hail the Intertie Effort

"The construction of this extra high voltage intertie will be a significant forward step in technological advancement for America in the power field. It has profound beneficial implications for your systems and your consumers, as well as all American power consumers.

"I am proud of the leadership we have given in this effort. It clearly demonstrates that the Federal Government has a very vital role to play in providing resource development leadership."

KENNETH HOLUM,
Assistant Secretary,
Water and Power Development,
Department of the Interior.

"This great high-voltage, power transmission intertie is a major development in a dream that has spanned three decades. We who live in the Northwest owe the region's industrial firms and the private and public utilities a large debt of gratitude for their work on behalf of the electrical project that will benefit so many fellow Americans."

CHARLES F. LUCE,
Administrator,
Bonneville Power Administration.

The Other Participants

Through the Federal multipurpose dams and transmission lines in the Intertie area, there is substantial Federal Government interest and participation in the PNW–PSW Intertie by the Bureau of Reclamation and the Bonneville Power Administration.

However, with major portions of the plan being accomplished by private companies and a public agency, the *Reclamation Era* extends congratulations to these participating organizations and their top officials:

SAMUEL NELSON, General Manager and Chief Engineer
Department of Water and Power
City of Los Angeles, Los Angeles, Calif.

THOMAS W. DELZELL, Chairman of the Board and Chief Executive
Portland General Electric Company, Portland, Oreg.

ROBERT H. GERDES, President
Pacific Gas and Electric Company
San Francisco, Calif.

J. K. HORTON, President
Southern California Edison Company
Los Angeles, Calif.

WALTER T. LUCKING, President
Arizona Public Service Company, Phoenix, Ariz.

DONALD McCLUNG, President and Chief Executive Officer
Pacific Power and Light Company, Portland, Oreg.

J. F. SINNOTT, President
San Diego Gas and Electric Company, San Diego, Calif.

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-6111-A	Colorado-Big Thompson, Colo	June 7	Completion of Granby dam spillway, modification.	Syblon-Reid Co., Ogden, Utah	$206,798
DS-6190	Pacific Northwest-Pacific Southwest Intertie, Nev.	Apr. 30	High-voltage a-c d-c converter terminal, Mead substation. (Negotiated contract).	General Electric Co. and ASEA, Schenectady, N.Y.	24,990,485
DS-6226	do	Apr. 7	Aerial photographs, maps, and surveys for 750-kv d-c transmission line, Luning to Nightingale, Nev., Section 3. (Negotiated Contract).	E. H. Schmidt and Associates, Inc. and Sprout Engineers, Inc., Tulsa, Okla.	161,000
DC-6232	Central Valley, Calif	Apr. 23	Furnishing and installing three vertical-centrifugal-type pumping units for completion of Corning canal pumping plant.	Remsco Associates, Matawan, N.J.	332,934
DC-6236	do	Apr. 27	Construction of Little Panoche Creek detention dam utilizing riprap on upstream slope.	Darkenwald Construction Co., Inc., and Morrison-Knudsen Co., Inc., Sacramento, Calif.	2,263,939
DS-6239	Pacific Northwest-Pacific Southwest Intertie, Nev.	June 7	Location, surveys, maps, and geology for 750-kv d-c transmission line, Nightingale, Nev., to Oregon line, Section 4. (Negotiated contract).	Thomas Engineering and Surveying Co., Columbus, Ohio.	200,669
DC-6241	Columbia Basin, Wash	May 28	Construction of Radar pumping plant and discharge lines WB3A and WB3B, Schedule 1.	Sivers Construction Co., Portland, Oreg.	1,502,077
DC-6242	Silt, Colo	Apr. 30	Construction of Davie ditch	Crown, Inc., Hot Springs, S. Dak.	308,035
DC-6248	Colorado River Storage, Colo	Apr. 28	Construction of the Crystal dam access road.	H-E Lowdermilk Co., Englewood, Colo.	936,269
DC-6250	Central Valley, Calif	May 12	Construction of 27 miles of pipelines for Main aqueduct and lateral system.	Baker-Anderson Corp., Santa Ana, Calif.	1,878,833
DS-6252	Pacific Northwest-Pacific Southwest Intertie, Ariz.-Nev.	May 19	Two 450,000/600,000-kva autotransformers for Liberty and Mead substations.	General Electric Co., Denver, Colo.	1,001,494
DC-6255	Central Valley, Calif	June 3	Completion of Mile 18 pumping plant, switchyard, and appurtenant works.	Gunther and Shirley Co. and E. V. Lane Corp., Sherman Oaks, Calif.	2,832,607
DS-6257	Pacific Northwest-Pacific Southwest Intertie, Ariz.	May 10	Twelve shunt reactors for Liberty substation.	Westinghouse Electric Corp., Denver, Colo.	126,72[illegible]
DC-6258	Chief Joseph Dam, Wash	May 13	Construction of 1.7 miles of pipeline for Upper Okanogan siphon.	B & B Contracting Corp., Anacortes, Wash.	284,06[illegible]
DS-6260	Office of Economic Opportunity, North Carolina, Oklahoma, New York, Nebraska, New Mexico, and Idaho.	May 4	Furnishing and erecting portable family dwellings at Job Corps centers: Oconaluftee Treasure Lake, Iroquois, McCook, Snake River, and Mexican Springs.	The Commodore Corp., Omaha, Nebr.	220,15[illegible]
DC-6261	San Juan-Chama, Colo	May 11	Construction of the 8.5-mile Blanco tunnel, diversion dam, and appurtenant structures, Schedules 1 and 4.	Colorado Constructors, Inc. and A. S. Horner Construction Co., Inc., Denver, Colo.	10,600,07[illegible]
DC-6262	Pondera County Canal and Reservoir Company, Montana.	May 7	Construction of Swift Dam on Birch Creek	Al Johnson Construction Co., Minneapolis, Minn.	2,870,68[illegible]
DC-6263	Central Valley, Calif	May 17	Construction of concrete lining, and one concrete bridge for realinement of Delta-Mendota canal.	Service Construction Co. of Southern California, Sun Valley, Calif.	694,35[illegible]
DC-6265	Chief Joseph Dam, Wash	May 14	Construction of headworks and Main canal extension.	Roger E. Holmes, Olympia, Wash.	249,59[illegible]
DS-6266	Central Valley, Calif	May 7	Structural steel for trashrack and girders for San Luis dam.	Bannock Steel Corp., Boise, Idaho.	160,76[illegible]
DC-6271	do	May 12	Repair of Trinity River bridge and channel improvement Carrville to Cedar Creek.	Myers Construction Co., Redding, Calif.	222,7[illegible]
DC-6272	Spokane Valley, Wash	June 11	Construction of 86.2 miles of pipelines for Spokane Valley distribution system, Schedules 2, 3, and 4.	Lester N. Johnson Co., Spoakne, Wash.	2,140,1[illegible]
DC-6272	do	June 3	Furnishing and installing 11 50,000-gallon steel tanks for Spokane Valley distribution system, Schedule 5.	Chicago Bridge and Iron Co., Seattle, Wash.	446,5[illegible]
DC-6275	Colorado River Storage, Ariz	June 18	Construction of stage 02 additions to Pinnacle Peak substation.	Jelco, Inc., Salt Lake City, Utah	477,7[illegible]
DC-6277	Fryingpan-Arkansas Colorado	May 26	Construction of 11 miles of Divide, South Fork, and Chapman tunnels, three diversion dams, and appurtenant structures, South Side collection system.	Winston Brothers Co., etc., Minneapolis, Minn.	17,556,1[illegible]
DC-6289	Office of Emergency Planning, Oregon.	June 17	Rehabilitation of Main canal	Coast Contractors, Inc., Lake Oswego, Oreg.	309,3[illegible]
DC-6301	Delivery of Water to Mexico, New Mexico.	June 3	Extension of Wellton-Mohawk outfall drain to Morelos Dam. (Negotiated contract).	Morrison-Knudsen Co., Inc., South Gate, Calif.	2,501,1[illegible]
100C-745	Columbia Basin, Wash	Apr. 29	Construction of buried pipe drains for D20-235 drain system, Block 20.	George A. Grant, Inc., Richland, Wash.	109,[illegible]
100C-747	do	Apr. 23	Construction of drains for Blocks 86, 87, and 881.	Vern Haisch Construction Co., Pasco, Wash.	106,1[illegible]
100S-753	Spokane Valley, Wash	Apr. 14	Deepwell pumping units for water supply wells.	Layne and Bowler, Inc., Memphis, Tenn.	199,[illegible]
100C-755	Columbia Basin, Wash	June 10	Construction of pipelines, laterals and wasteway, and pumping plant, Block 161.	John M. Keltch, Inc., Pasco, Wash.	219,[illegible]
100C-770	Office of Emergency Planning, Oregon.	Apr. 22	Furnishing and operating temporary pumping facilities for the Dee Irrigation District and the Farmers Irrigating Co. (Negotiated contract.)	Carl M. Halvorson, Inc., Portland, Oreg.	187,[illegible]
200C-587	Office of Emergency Planning, California.	Apr. 2	Emergency repair to roads in the Hoopa Valley Indian Reservation.	Tonkin Construction Co., Willow Creek, Calif.	144,[illegible]
400C-288	Weber Basin, Utah	May 4	Construction of recreational facilities for Willard South recreation site and gravel surfacing for roads.	Olsen Construction and Engineering Co., Ogden, Utah.	222,[illegible]
500C-199	Canadian River, Tex	May 19	Construction of boat launching ramp and public use facilities for Sanford reservoir area.	E.D. Baker Corp., Borger, Tex.	144,[illegible]
600C-210	Missouri River Basin, Wyo.-Mont.	May 19	Construction of boat ramps and roads for three Yellowtail reservoir areas.	Weaver Construction Co., Iowa Falls, Iowa.	380,[illegible]

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Major Construction and Materials for Which Bids Will Be Requested Through August 1965*

Project	Description of work or material
Arbuckle, Okla.	Constructing the Wynnewood Pumping Plant and about 18 miles of pipelines. Work will also include constructing a small reservoir. Near Davis and Wynnewood.
Do.	Constructing roads and recreational facilities at Arbuckle Reservoir. Near Sulphur.
Baker, Oreg.	Constructing Mason Dam, an earth and rock fill structure about 170 ft high, 880 ft long, containing about 800,000 cu yd of materials, and appurtenant features. The spillway will consist of an ogee crest and open chute in the left abutment and a stilling basin. The tunnel outlet works will be located in the left abutment. Work will also include constructing 0.8 mile of access road. On the Powder River, about 18 miles southeast of Baker.
Blackfeet Indian Irrigation, Mont.	Constructing Lower Two Medicine Dam with a concrete overflow ungated center section about 35 ft high and 185 ft long, earth dike embankments on both abutments about 150 and 750 ft long, resepectively, and an outlet works consisting of two 3-ft by 3-ft 6 in. conduits discharging into a stilling basin. Work will also include constructing a bridge downstream from the dam. On Two Medicine Creek, about 14 miles southwest of Browning.
Canadian River, Tex.	Constructing roads and recreational facilities at Sanford Reservoir. Near Fritch.
Central Valley, Calif.	Earthwork and structures for about 20 miles of concrete-lined canal with bottom width of 50 ft and side slopes about 70 ft long. Canal is to be lined with 4.5-in.-thick unreinforced concrete. San Luis Canal, Reach 5, north of Kettleman City.
Do.	Constructing six turnouts in the San Luis Canal with inlets and precast concrete barrels to vary from 24- to 60-in. diameter. Near Los Banos.
Chief Joseph Dam, Wash.	Reshaping 6.4 miles of Main Canal and constructing a rotating fishscreen structure. About 8 miles west of Oroville.
Do.	Rehabilitating the Oroville-Tonasket Main Canal will consist of removing wood flumes and replacing with new construction and about 250 lin ft of 78-in.-diameter precast concrete pressure pipe siphon. Near Oroville.
CRSP, Ariz.	Work will consist of excavating rock and concrete to complete the Glen Canyon Dam left spillway tunnel, other work and epoxy repairs to existing tunnel lining. Near Page.
CRSP, Colo.	Completing the Blue Mesa Powerplant and Switchyard will consist of placing concrete for turbine embedment and generator support; installing two 41,500-hp, 200-rpm, vertical-shaft, hydraulic turbines, the transformer bank, switchyard, and other mechanical and electrical equipment; constructing interior masonry wall partitions; placing concrete floor surfacing, and applying architectural finishes. About 25 miles west of Gunnison.
Do.	Constructing the Skito Substation, Stage 1, will consist of constructing foundations; furnishing and erecting steel structures; furnishing and installing switches, instrument transformers, and associated electrical equipment. About 1 mile west of Gunnison.
Do.	Earthwork, culverts, and bridges for several short access roads from existing roads into the Cortez-Curecanti Transmission Line right-of-way. Between Cortez and Cimarron.
Columbia Basin, Wash.	Constructing about 26 miles of buried pipe drains, Block 46. East of Othello.
Fryingpan-Arkansas, Colorado.	Constructing Sugar Loaf Dam, an earth and rockfill structure, about 134 ft high and 2,130 ft long, containing 1,650,000 cu yd of materials, and appurtenant features. The spillway will consist of a morning glory inlet structure, a 20-ft-diameter conduit in the left abutment and a stilling basin. The outlet works will consist of an intake structure, a 7-ft-diameter upstream conduit, a gate chamber, and an 11-ft-diameter downstream conduit in the right abutment and a control structure. On Lake Fork Creek, about 5 miles west of Leadville.
Lyman, Wyoming.	Constructing Meeks Cabin Dam, a rolled earthfill structure about 175 ft high and 3,100 ft long, containing about 3,500,000 cu yd of materials, and appurtenant features. The spillway will consist of an intake and crest structure, a 30- by 15-ft closed conduit in the embankment, and a stilling basin. The outlet works will consist of an intake structure, an 8-ft-diameter upstream pressure conduit, a gate chamber, a 9-ft 6-in.-diameter horseshoe conduit containing a 62-in.-diameter pipe, a control structure, and a stilling basin. On Blacks Fork, 33 miles southwest of Urie.
MRBP, Iowa	One 3-phase, 30,000-kva, 154-115-69-13.8-kv mobile power autotransformer.
MRBP, Kansas	Twelve motor-driven hoists for 50- by 21.76-ft radial gates for Glen Elder Dam. Estimated weight: 183,000 lb.
MRBP, Nebraska	Earthwork and structures for about 13 miles of Farwell Main and Central open laterals with a bottom width of 3 ft, of which about 0.6 mile will be lined with compacted earth. Near St. Paul.
Do.	Stage 02 additions to the Alliance Substation will consist of constructing foundations; furnishing and erecting steel structures; transporting three single-phase, 20,000-kva transformers from Gering, Nebr., and installing the transformers; and furnishing and installing associated electrical equipment. Near Alliance.
Do.	Installing about 3,200 steel jacks along Frenchman Creek for erosion control. Between Enders Dam and Hamlet.
MRBP, South Dakota.	Stage 07 additions to the Sioux Falls Substation will consist of constructing foundations; furnishing and erecting steel structures; furnishing and installing three single-phase, 230/115/13.2-kv, 33,333-kva autotransformers, one 3-phase, 115-kv, 75,000-kva regulating transformer, three 13.2-kv, 4,000-kva reactors, two 230-kv, one 115-kv, and one 13.2-kv circuit breakers, and associated electrical equipment. About 4 miles northeast of Sioux Falls.
MRBP, Wyoming and Nebraska.	Constructing the Glendo-Stegall single-circuit, 3-phase, 230-kv transmission line about 74 miles long. Work will consist of clearing right-of-way; constructing footings; furnishing and erecting steel towers; and furnishing and stringing three 1,272 MCM, ACSR conductors and two 0.5-in. high-strength, steel-strand overhead ground wires. (Extending from the vicinity of the Glendo Reservoir, Wyo., to a point near Stegall, Nebr.)
Parker-Davis, Ariz.	One 3-phase, 54/72/90-mva, 220/115/13.8-kv autotransformer for Stage 04, Coolidge Substation.
Rogue River Basin, Oreg.	Constructing a 5-ft-high, 60-ft-long, reinforced concrete diversion dam. About 22 miles northeast of Medford.
Silt, Colo	Constructing Silt Pumping Plant, a sump-type, four-unit plant, consisting of a reinforced concrete substructure, a superstructure of structural-steel frame with concrete-masonry unit walls, and a bridge crane for servicing the pumping units. The pumps, electric motors, and controls will be contractor furnished. Near Silt.
Spokane Valley, Wash.	Constructing concrete structures at ground surface and installing pumps and motors for 34 wells. Near Spokane.

* Subject to change.

In its assigned function as the Nation's principal natural resource agency, the Department of the Interior bears a special obligation to assure that our expendable resources are conserved, that renewable resources are managed to produce optimm yields, and that all resources contribute their full measure to the progress, prosperity, and security of America, now and in the future.

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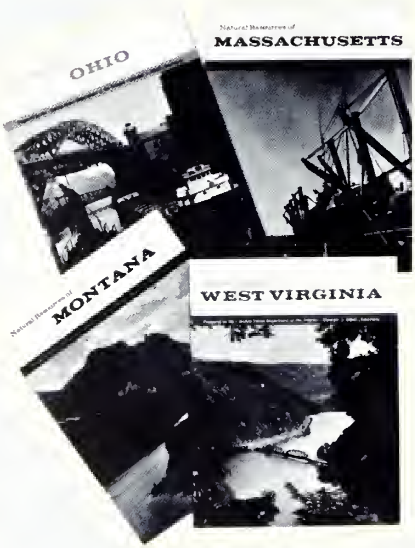

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November 1965

RECLAMATION ERA

Cover photo caption inside.

Job Corps Youths Are Commended for Their Accomplishments
Story: "These Young Men"

Pioneer Spirit Remains in the Celebrating 75-Year-Old State of Wyoming

A Water System in Desert Land Is Being Built for the Navajo Indians

Reclamation ERA

NOVEMBER 1965

Volume 51, No. 4

OTTIS PETERSON, Assistant to the Commissioner—Information
GORDON J. FORSYTH, Editor

COVER PHOTO. **Spraying 50-foot "rooster tails" behind them, 13 unlimited hydroplanes raced last August over a thrill-packed, 3-mile course on the reservoir behind the Bureau's new Willard Dam, Utah. See the story on page 108. Photos by Mel Davis.**

United States Department of the Interior
Stewart L. Udall, Secretary

Bureau of Reclamation, Floyd E. Dominy, Commissioner

Washington Office: United States Department of the Interior, Bureau of Reclamation, Washington, D.C., 20240.

Commissioner's Staff

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Chief Engineer, Denver, Colorado	B. P. Bellport

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REGION 3: A. B. West, Regional Director, Administration Building, Boulder City, Nev., 89005.
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Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C., 20240. Use of funds for printing this publication has been approved by the Director of the Bureau of the Budget, January 31, 1961.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Price 30 cents (single copy). Subscription price: $1.00 per year (25 cents additional for foreign mailing).

75 Years of Statehood for . . .

WYOMING

"Home on the Range"

by DR. T. A. LARSON

WHEN statehood for Wyoming passed the U.S. House of Representatives in March 1890, almost 2,000 miles west of Washington, D.C., jubilation erupted in all towns of the would-be State. Church bells rang, firebells clanged, train whistles shrieked, trumpets blared, bonfires blazed, and citizens cheered.

A former Governor, George W. Baxter, declared: "It means the dawning of a brighter day, the beginning of an era of unparalleled prosperity."

That Wyoming should have achieved statehood so soon after the winter of 1886–87 bordered on the miraculous. In that bitterly cold and blustery winter 3 years earlier, Wyoming ranchers had suffered cattle losses variously estimated at from 15 to 75 percent. Many, of course, were wiped out; most of them stoically started to rebuild their herds, exhibiting that rugged perseverance and pride which have since become trademarks of the Equality State and its people.

The admission to the Union of Wyoming as a State at such a low ebb of its economy, as well as the admission of the Dakotas and Montana the previous year, is said to have been due to political considerations. However, the politics were far away in Washington, and did nothing to dampen the enthusiasm of the settlers on the plains who celebrated the great event in 1890.

This year, three-quarters of a century later, the descendants of those first Wyomingites are again exhibiting the same colorful and lusty pioneer spirit.

The State has traveled a long road since statehood.

During much of the 19th century, Wyoming was "a thoroughfare rather than a destination." It is true that trappers had lingered while they pursued beaver in lush and beautiful valleys, but with the decline of the fur trade, people passed through as quickly as possible on their way to Oregon and California.

While large areas of sagebrush and outcrops of barren rock repelled farming in many locations, other areas were fertile and rewarding to the sturdy and resourceful hand. And while prospectors searched, mostly in vain, for valuable deposits of precious metals, wild game and spectacular mountain scenery intrigued sportsmen and attracted a few permanent settlers.

Reached by Railroad

The laying of the rails for the Union Pacific Railroad across the area led Congress to establish Wyoming Territory in 1868. Thus, people who considered themselves pioneers rode to their frontier homes in Wyoming, not in covered wagons, but in railway coaches or pullman cars.

As the railroad advanced, several towns—Cheyenne, Laramie, Rawlins, Green River and Evanston—were strung like beads on a string across

the southern part of the Territory. Then completion of the railroad was followed by an economic setback which threatened to erase the young Territory; even President U. S. Grant, in December 1872, favored distributing the land among surrounding Territories and States.

This debacle was averted, however, and the population increased to 20,000 by 1880, enough to keep the struggling Territory from being sidelined. Then in the 1880's came a spectacular boom in the open-range cattle business, as hundreds of entrepreneurs arrived with vast herds from Texas and other places. Where there had been only 450,000 cattle in 1879 there were 1,500,000 in 1885. As the range became overcrowded, the cattlemen, who had been depending almost entirely on public land, realized that they must acquire title to more of the land they used. More land was filed on in 1884—549,386 acres—than in all the previous 14 years taken together, and the number of filings in 1885 and 1886 approached those of 1884. The picture in the middle 1880's was one of big cattlemen grabbing up what land they could by fair means or foul.

Winter losses were a part of the open-range cattle business. The common view, said a Laramie editor in 1876, was that it is cheaper to lose 3 or 4 percent than to put up hay, provide shelter and hire herders. Ten years later, the winter of 1886–87 took its grim toll and picking up the pieces afterward took time. Genuine rehabilitation would take many years and would involve smaller herds, improved management and greater attention to the need for shelter, feed, and water.

Statehood brought with it almost universal optimism. In the newborn State of 62,555 people (including 1,850 Indians on the Wind River Reservation) joy soon gave way to gloom, as economic growth proved elusive. The State's property valuation for tax purposes held steady at about $30 million every year in the period 1890–98. No important industrial development occurred, although there was a small expansion in coal mining. Delegate to Congress Joseph M. Carey had assured the U.S. House of Representatives in 1890 that Wyoming had unsurpassed mineral resources, but nevertheless most of the State's minerals were what economists call "neutral stuff" which could not,

Built by the Bureau of Reclamation, Buffalo Bill Dam on the Shoshone River 7 miles west of Cody, Wyo., is one of the first high concrete dams constructed in this country.

for the time being at least, be marketed at a profit.

Reclamation Possibilities

At first Mr. Carey also was overoptimistic about the possibilities of reclamation. When private enterprise irrigated only hay meadowland near streams, Wyoming's first State engineer Elwood Mead and his close associates Senators Francis E. Warren and Carey turned to the State and Federal Governments for aid.

In 1894, Congress passed the famous Carey Act, which was named after its author. Several years later, dissatisfied with the slow progress under the Carey Act, irrigation promoters went again to the Federal Government. Wyoming's Senator Warren and Representative Frank W. Mondell worked hard for passage of the Newlands Act of 1902. Soon reclamation claimed the combined interest of private, State, and Federal effort.

Wyoming's first Federal project, the Shoshone in 1904, took over a stalled Carey Act project which had been started by William F. Cody. By 1910, Buffalo Bill Dam was completed and crops were growing on 15,000 acres of the project in the vicinity of Ralston, Powell, and Garland. Completion of the State's second Federal project, the North Platte, soon followed, involving construction of the Pathfinder Dam, 40 miles southwest of Casper.

As reclamation was pushed with vigor in the years just before the first World War, so also was dryfarming. "All crops must be irrigated," the Station Agriculturist at the University of Wyoming Experiment Station had warned in 1891. Yet the temptation to try dryfarming proved irresistible, and where only a few bold spirits had tried it before 1900, a few thousand set to work in the next decade, especially in the eastern counties where normal rainfall approached 16 inches annually.

After the legislature in 1907 appropriated $5,000 for dryfarming experiments, the State employed a Director of Dryfarming Experiments, who traveled all over the State giving advice and assistance. Congressman Mondell aided the cause by introducing and ushering through Congress the

Today oil production is Wyoming's leading industry, accounting for more than one-third of her income. (U.W. Library Photo)

Established as a land-grant college 3 years before Wyoming became a State, the University of Wyoming has a 96-acre campus. It is attended by more than 5,000 students. (U.W. Photo)

320-acre homestead law of February 1909. Unhappily, in 1910 and 1911 came drought, widespread crop failures, and reduced dryfarming acreages.

Land Patenting

Inflation and prosperity in 1917 and 1918 persuaded many rural people to enlarge their holdings by exhausting whatever unused rights they had under the various land laws, and townspeople joined in the homesteading spree. Almost 10 million acres of land were patented in the 1920's, nearly doubling the amount in private ownership, and bringing the total up to 40 percent of the State's area. Another million and a half acres passed to patent in the 1930's before vacant, unreserved, and unappropriated lands were withdrawn by Executive order in 1934.

Despite the land rush of the 1920's, the number of farm and ranch units and the rural farm and ranch population increased only slightly. People already on the land in 1919 sooner or later came into possession of most of the newly homesteaded land. Moreover, they did not plow up much of the newly acquired land. Cropland harvested increased only from 1,153,624 acres in 1919 to 2,007,751 acres in 1929. The acreage harvested in 1929 represented only 3 percent of the State's area, illustrating once again the persistent dominance of livestock.

Congress frowned on new reclamation starts in the 1920's as emphasis shifted to salvaging old projects. In 1920 the U.S. Bureau of Reclamation was persuaded to try rehabilitating the Riverton Project. After much pleading, Senator John B. Kendrick in 1933 won President Franklin D. Roosevelt's approval for the Casper-Alcova Project, known as the Kendrick Project after 1937.

In the 20 years since World War II, Wyoming people have enjoyed good times. And yet there has been no spectacular economic growth. The State's increase in population in the decade 1950–60 was only 13.6 percent, which may be compared with 18.5 percent for the United States. In 1965 the State is what it has always been, mainly a producer of raw materials to be exported for processing elsewhere.

In terms of present cash receipts, production of minerals is the leading industry, agriculture-livestock is second, and tourism is third. Oil and gas (mostly piped out) bring in as much money as agriculture-livestock and tourism taken together, while uranium, coal, trona, and iron ore bring in additional millions.

Cash value of product, however, does not tell the whole story. Economic multiplier studies suggest that the minerals dollar has less impact on the State than the agriculture or tourist dollar, since so many of the minerals dollars go to outside owners. A University of Wyoming economist has calculated that minerals in 1963 were responsible for 30.9 percent of the State's total economic activity; agriculture-livestock, 20.3 percent; the Federal Government, 11.5 percent; out-of-State travelers, 10.1 percent; investment in construction including that of the Federal Government, 8.6 percent, and manufacturing, 5.9 percent.

Results of Multiple Purpose

In postwar years the U.S. Bureau of Reclamation has spent more than $150 million on multiple-purpose projects in the State. These projects provide power, recreation, supplementary irrigation water, and a small number of new irrigated farms. About 2 million acres of the State's 62 million acres are irrigated, the main crops being hay, sugarbeets, and dry edible beans.

Outstanding among the newer Reclamation projects are Glendo and Boysen. Also the Flaming Gorge Dam in Utah has made a reservoir which extends almost as far north as Wyoming's city of Green River.

Wyoming became a great oil-producing State in the years after the Second World War, as production rose fourfold, leveling off at about 140 million barrels annually in the 1960's. Unhampered by proration, Wyoming ranks fifth among the States in petroleum production.

The fastest-growing industry in the 1960's is tourism, with Grand Teton National Park and Yellowstone National Park each welcoming about 2 million visitors annually.

Expanded iron ore output, production of trona and uranium, two huge coal-burning steam powerplants at Glenrock and Kemmerer, and installation of intercontinental missiles around Cheyenne have bolstered the economy without satisfying the urge for faster growth. Various State and local agencies have been trying to diversify the economy and to reduce the considerable loss in employment which comes in winter. At present, the State has the smallest manufacturing employment of the 50 States (6,500 in April 1965).

Industrialization and diversification (and court-ordered reapportionment), if they come, could weaken the influence of the Wyoming Stock

Dr. T. A. Larson, author of the article, is head of the history department at the University of Wyoming in Laramie.

Growers Association, which has always been very powerful in the State's politics. Conceivably the State might then even lose its Cowboy State image.

Wyoming has another name besides that of Cowboy State. It is also called the Equality State because it was first among the States to give women full rights to vote and hold office. Although all States are now equality States, Wyoming will ever keep fresh the memory of its pioneering in the realm of women's rights.

Meanwhile, the people of Wyoming continue to be fiercely proud of the record they have made in the face of obstacles which would have stopped less energetic, less hard-working folk. Until new payrolls come and bring great changes, the 350,000 people of the Cowboy State will treasure the privilege of living in an uncrowded commonwealth—the Old West's home on the range. # # #

A Wait of Many Moons For . . .

Irrigation to the Navajo Tribe

by **HAROLD J. BOYD and SHIRLEY A. ALLISON**
Bureau of Reclamation
Farmington, New Mexico

In barren northwest New Mexico, one of the West's long-awaited irrigation projects is taking shape. More than 100,000 acres of the parched but fertile desert will be transformed by the miracle of water for a group of resourceful native Americans—the Navajo Indians.

Calling themselves "Dineh" (The People), the Navajos and their existence in a formidable mountain-desert area is an amazing paradox. While other tribes have vanished or are vanishing, the Navajo has not. Numbering over 85,000—and still growing—they are this country's largest Indian tribe.

Other Indians have deserted the log house and the tepee for more modern housing. But some Navajo families still live in hogans, often miles from the nearest water and neighbor. And their ancient language is still, in many cases, the only language they speak.

The People first came into the light of history while they were living in an area along the Colorado-New Mexico boundary between the Chama and upper San Juan Rivers.

This was in the late 14th or early 15th century. From there they spread south and west into what is now known as the Navajo country, the largest Indian reservation in the United States, encompassing about 24,000 square miles of rugged land in arid parts of Arizona, New Mexico, and Utah.

In the early 1600's the Navajos were an aggressive and powerful tribe. They acquired sheep and horses from the Spaniards and learned from them to work with metal and wood. The Navajos are famous for their adaptability and early culture. And while they copied much from their neighbors, they improved on the things they copied.

Until the arrival of white soldiers in Navajo territory, these Indians were seminomadic. They lived in loosely defined areas, were not friends with other tribes, and regarded the oncoming white settlers as enemies. They retaliated against their enemies with all their strength, making Navajo country dangerous for anyone but a Navajo.

The first military expedition against The People was in the winter of 1846, when Colonel Doniphan and 350 soldiers met with them at Bear Springs, later known as Fort Wingate, and signed a nominal treaty.

Since there was no acknowledged head of all the Navajos, any Navajo leader who signed a treaty was responible for his own people only. This fact was not understood by the Army, which held all Navajos responsible for all treaty promises. This led to retaliation, further treaties, increased misunderstanding, and more raids for the next 20 years. Finally, it was decided to round up The People and send them to Fort Sumner, N. Mex., where they were to settle down, learn the art of farming, and become peaceful citizens insofar as they were able.

Submission Wrested

Colonel Kit Carson was given the task of locating and rounding up the Navajos. They hid in such strongholds as Canyon de Chelly where they defied the troops' advances. It became necessary to kill their sheep, destroy their cornfields, devas-

The giant tunneling "Mole" looms into the portal to take over its work on the already started Tunnel No. 1 of the water development project.

tate their orchards, and to literally starve them into submission. Even then, not all the Navajos surrendered. Bands of them fled and eluded the troops until they were finally left unmolested.

After 4 heartbreaking years, those who had been taken to Fort Sumner petitioned the Peace Commission to be allowed to return to their old homes and promised they would cause no more trouble. The historic treaty of 1868, which resulted, recorded the promises made by the white men.

A provision of major interest in the treaty is that productive land would be provided for each Navajo family. Since the land already is fertile the development of irrigation is the ingredient of principal need.

When freed of their captivity, the Navajo people made a new start toward progress. They exhibited stamina, and an urge to work and succeed.

In the first part of this century, came encouragement. The communities of Aztec and Blanco, N. Mex., received an irrigation project survey crew headed by the Turley Brothers, Jay and Guy. The crew, including two local men, Albert "Bert" Jacquez and Joe Lujan, battled problems of the rugged terrain around the Pine and San Juan Rivers centering around the present Navajo Dam.

On their trips into town the men fired the dreams of the people with their visions of an irrigation dam on the San Juan that might turn desert into fertile land. The determined crew continued their work through blazing summer sun. Winter nights were freezing, but the survey went on.

These men lived off the country and crossed spring-flooded rivers on rafts. Guy Turley spent 16 hours a day for weeks compiling maps and details of the survey to comply with demands of a financing group.

Jay made preliminary filings in late 1909, but failed to interest private capital or the Federal Government in developing the project.

In 1920, and again in 1925, Turley's proposal was investigated by the Bureau of Indian Affairs, but each time it was rejected as not being feasible under the existing economic conditions. The present layout for canals and reservoirs, however, resembles that in an extensive survey made in the late 1920's by Herbert W. Yeo, State Engineer of New Mexico.

The Governor's Request

Additional studies were made for a number of years, but nothing was resolved until the Gov-

Rugs made by the hand machine such as is used by the Navajo woman, provide a source of income.

ernor of New Mexico, in a letter of March 4, 1953, asked the Federal Government to develop a project that would utilize the waters of the San Juan River to irrigate lands adjacent to and within the Navajo Indian Reservation. The Secretary of the Interior promptly directed the Bureaus of Reclamation and Indian Affairs to cooperate in an investigation of the project as the Governor proposed.

The two Bureaus prepared a report proposing construction of a dam on the San Juan River, and an irrigation system for lands of both Indian and non-Indian farmers.

The New Mexico Interstate Stream Commission recommended that the project be developed primarily for the Navajo Indians, and that non-Indian lands be excluded.

After concurrence of the Navajo Tribal Council, a supplemental report prepared by the Bureau of Indian Affairs, proposed development of 110,630 acres of land.

Authorization of the project by the act of June 13, 1962, by the 87th Congress, finally brought to reality the provisions of the treaty of 1868 and included development for irrigation. In the best possible fulfillment of the national obligation to the Navajo Tribe, modern machinery and methods are now employed in constructing the long-awaited project.

While the Bureau of Reclamation will construct the dams, tunnels, and other major features, it is a Bureau of Indian Affairs' project. That agency will develop the farm units with the Navajo Tribe. This BIA responsibility not only includes the training of Navajo farmers, but also the leveling of the farm units, construction of irrigation ditches, erection of buildings, and construction of farm-to-market roads.

With elevation differences of nearly 2 miles between the highest and lowest points, the San Juan River Basin is one of extreme contrast in both topography and climate. Several mountain peaks on the northeast rim of the Basin reach more than 13,000 feet above sea level.

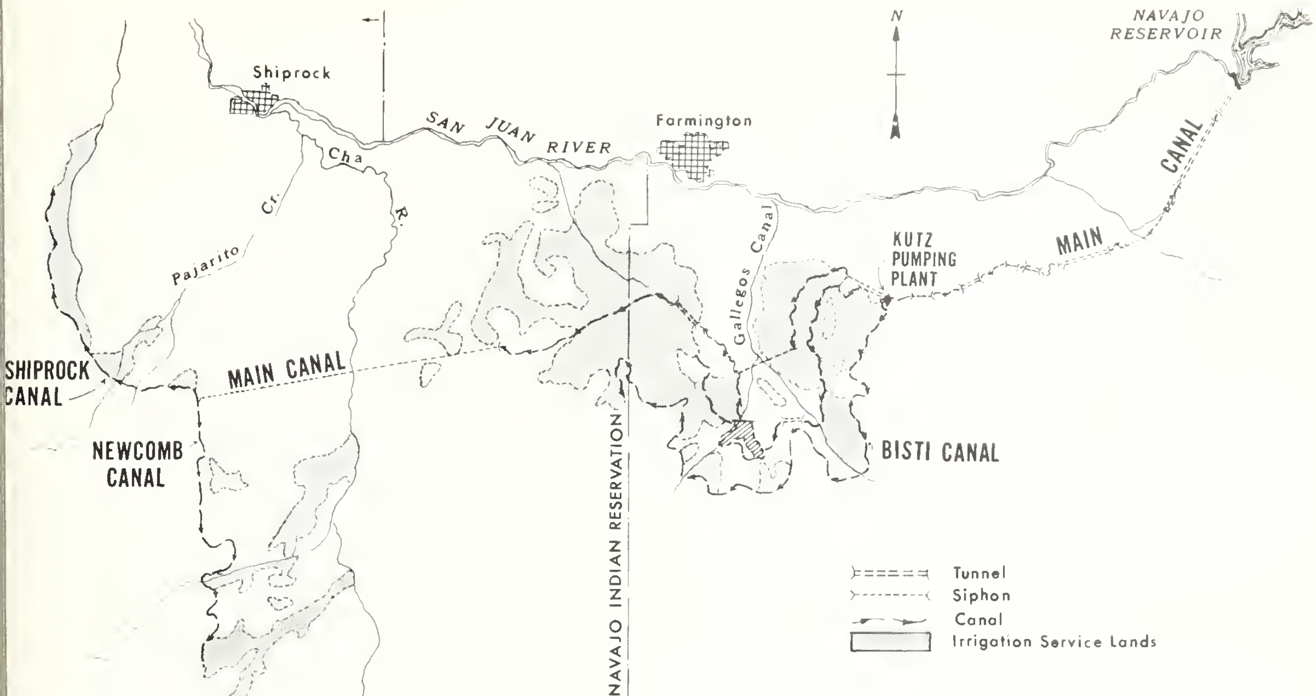
From these heights the peaks slope to a basin of 3,260 feet at the confluence of the San Juan and the Colorado Rivers. The tree-clad mountain areas also have clear, fish-stocked streams and small lakes. The foothill valleys are barren, but fertile and picturesque.

With an average precipitation of only 8 inches a year, stored water is necessary for successful crop production in the San Juan River basin. Under irrigation, it is expected the lands will be devoted primarily to alfalfa, beans, and irrigated pasture, with some acreage devoted to corn, oats, and barley. At present, however, all the lands in the project area are undeveloped and are used only for grazing.

Population Increase

Although the Navajo reservation population is now over 85,000, it is expected to approximate 200,000 by the year 2000. Hence, one of the strongest needs for this beneficial project is to help take care of the Navajo's fast growth. In bring-

This is a typical flock of sheep in Navajo land. Sheep raising is the largest source of income to the Navajo family.



NAVAJO INDIAN IRRIGATION PROJECT
NEW MEXICO

ing them a better standard of living, the Navajo Indian Irrigation Project will provide a means of self-support for 1,120 families on the farm units and create employment for an additional 2,240 families.

Construction of the project will generate an estimated 7,000 man-years of work at the project site and an equivalent of more than 12,000 man-years of work in other areas throughout the country which will provide the necessary services, materials, and equipment.

Families on the project lands will require more schools, housing, farm buildings, roads, fences, and utility installations. There also will be increasing demands for farm machinery, trucks, and automobiles.

A relatively large municipal and industrial water supply also will be provided by the project.

By the spring of 1964, the time had finally come to actually undertake construction of the $135 million resource development project. Work started immediately on Tunnel No. 1 and the main canal headworks, the first major feature. The next major feature, a 5-mile tunnel, was started in the early part of 1965.

An ultramodern machine, "The Mole," perhaps the most efficient equipment ever developed for large tunnel excavation, is at work in the 20-foot-diameter No. 1 tunnel. This huge burrower weighs about 280 tons and is 64 feet long. It is one of the first developed to excavate such a large tunnel in hard rock and is arousing considerable engineering interest among those who do tunneling work.

Reclamation will construct approximately 600 miles of canals and laterals, 40.8 miles of siphons, and a total of 13.1 miles of tunnels to deliver water from the existing Navajo Dam and reservoir on the San Juan River. Reclamation also will construct a powerplant and pumping plant to serve project lands situated above the main canal. Off-stream balancing reservoirs that will be filled by pumping during the off-irrigation season will be formed by earthfill dams.

After the initial delivery of water is made to project lands in 1971, approximately 10,000 acres for farming will be developed annually. Completion of construction will be in 1980.

As for the Bureau of Reclamation and its record of accomplishments in the field of water resource development, this sister agency to the Bureau of Indian Affairs is proud to take its know-how and experience to Indian country and to assist the Navajos in obtaining the basic ingredient—water—for building the firmer economy they so justly deserve.

# # #

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THE LEWISTON CENTER

"These Young Men"

Reclamation Commissioner Floyd E. Dominy gives the dedication address at an outdoor stage built by Corpsmen.

As half-time students, the Corpsmen study and receive individual help from instructors in the education room.

James M. Benge, automotive mechanic, explains the parts of the truck motor to Bruce K. Day, 20, from Seattle, Wash., and Bob Van Camp, 18, from Hayward, Calif.

Two years ago, President John F. Kennedy, speaking at the dedication of Whiskeytown Dam in northern California, said: "*Whenever we bet on the future of this country, we win.*"

In another dedication in the same area last May 27, Reclamation Commissioner Floyd E. Dominy repeated the lines uttered by President Kennedy, and added: "I feel certain he (President Kennedy) would have agreed with President Johnson and all of us here today that when we bet on the future of *these young men*, we will win again."

This was the reassuring theme at the dedication of the first two Job Corps Conservation Centers in California, also the first under the sponsorship of the Bureau of Reclamation. Commissioner Dominy dedicated the Centers—Lewiston and Toyon—at ceremonies attended by Job Corps officials from Washington, D.C., State and local leaders and townspeople.

After the dedication of these antipoverty Centers, the youthful Job Corps enrollees, who hailed from disadvantaged homes in diverse States, served as ushers and guides to the many guests and officials who stayed to shake hands with them and inspect their facilities.

Useful work for the 300 trainees at Lewiston and Toyon is the rewarding kind—mainly conservation, recreation, and beautification. Under specially selected supervisors, these young men have been clearing hazardous debris from around Shasta Lake, and working to control soil erosion and stabilize soil at various projects. In a continuing program, supplementing academic and vocational instruction, they will develop recreation areas, and improve access roads and trails, and fish and wildlife areas.

Firefighters

The eagerness of the boys to get to a brush fire and prevent its spread in agricultural areas—also one of their jobs—already has been noted in a July issue of the "Redding Record Searchlight" newspaper.

The article recounted that the Lewiston enrollees had put out a roadside brush fire which they happened upon while en route to other assignments. In the effort, two of the young men, Clinton Brown and William Hale, were burned on the hands and treated at Lewiston Center infirmary. However, the fire had been set by a flaming can of gasoline which a passing motorist had thrown out of the back of his pickup truck when he dis-

Photos by Wes W. Nell

covered it burning. Serious trouble was averted when vehicles loaded with trainees arrived on the scene and the young Corpsmen helped extinguish the blaze with axes, shovels, and fire extinguishers.

Their work in conservation normally occupies about 20 hours a week. Fifteen to twenty hours of schooling in basic and vocational subjects is given either by the Center's instructors, or through the school systems of a nearby community.

One such community training program has brought Corpsmen from both the Toyon and Lewiston Centers to night courses in auto mechanics and carpentry. These courses are conducted by the Shasta Junior College and held at the Redding High School building.

Such courses from educational institutions are only part of the cooperation provided by community organizations. The community businesses and churches helped the JCCC staff and their families and the enrollees to get settled, and made them welcome to the various social and business services available.

In demonstrating community spirit, the enrollees, on off-duty Saturdays, cleaned up a town cemetery, and then went to work on the city parks, also on their own time.

Directors Are Qualified

The principal person contributing to the success of the JCCC is the man filling the position of Director of the Center. Directors are between 30 and 45 years of age. They are required to have special leadership experience, as well as an interest in and an affinity for working with young men.

The Director's Deputies for Work Programs and Education and the Administrative Officer also are well-trained and skillful leaders. Competing the well-rounded staff—which numbers about 26 for a center of 100, and 36 for a 200-man Center—are competent cooks, clerks, instructors, resident workers, and work leaders.

Added to the basic program of worthwhile outdoor work projects and patient teaching are plenty of good food and recreation. This includes a few hours of basketball, checkers, or table tennis, or other such sport in the living area or a comparable recreation activity in town. Part of this new life, or all of it, is an improvement over a dismal past. And, the boys who apply themselves are advancing the way they have often wanted to—in a better present and toward a better future.

THE TOYON CENTER

A group of new arrivals pose at the entrance of their new home with John A. Dell, instructor, standing at far left.

An issue of clothing is being completed with both work and dress shoes. From left to right are: the one partially hidden and David Richardson, 17, Indianapolis, Ind.; Instructor Thomas and Gordon Sewell, auto mechanic.

The array of tools that they will have opportunities to use are being looked over by John Sonnik, 17, Fred Smithgall, 18, and Skip Saunders, 18, all from Pennsylvania, and instructor Thomas.

THE CASPER CENTER

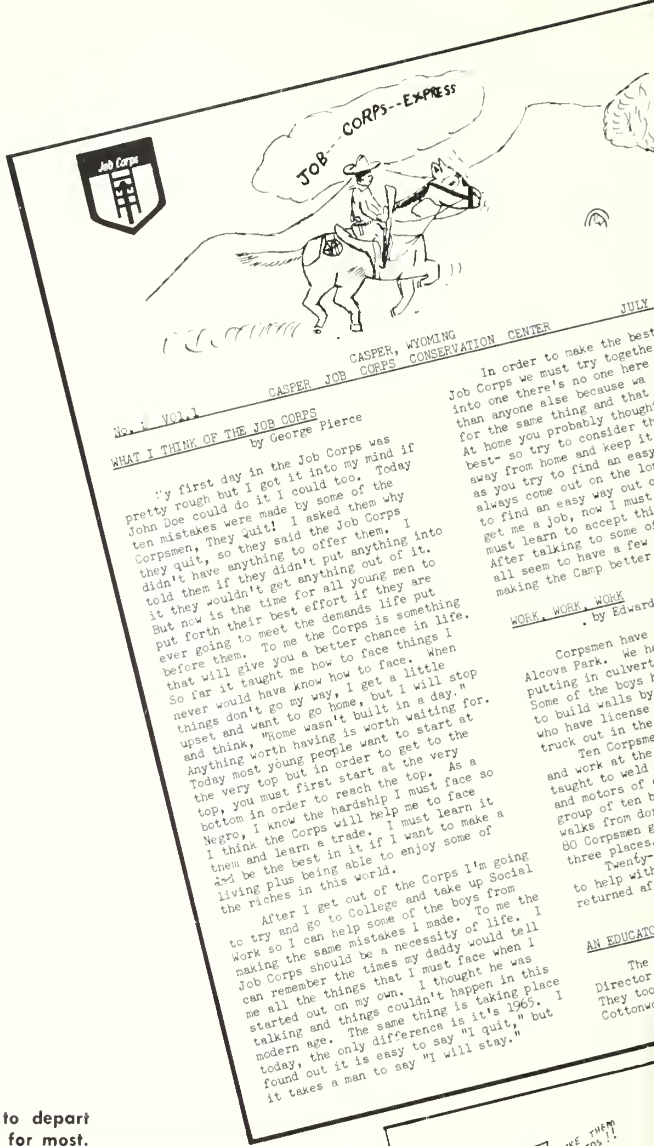
Happenings to the Corpsmen from Casper, are well described in "Job Corps Express" reproduced in part on this page. Although the young writers in the "Express" tell their story very well, we feel the reader would want to know that 50 percent of the youths at the Center are opening savings bank accounts in Casper, and 80 percent send money home.

Also, attendance at churches in Casper reached 80 percent of the Corps personnel, and the churches are running a pickup service and transporting a number of volunteers to their events.

A letter of thanks for their 2 weeks of flood work in the city of Denver during June was received from Mayor Tom Currigan. They did a magnificent job," the Mayor wrote.

Another letter from Joe Ciancio, Jr., manager of the Denver Department of Parks and Recreation said:

"It is impossible for me to express in words the city of Denver's thanks and appreciation for the work of the Job Corps' group of boys from Casper, Wyo., in their attitude, effort, and work production at the Overland Park Municipal Golf Course. This work experience should have been valuable to this group of boys, because of the variety of work encountered."



No. 1 VOL.1 CASPER JOB CORPS CONSERVATION CENTER
CASPER, WYOMING

WHAT I THINK OF THE JOB CORPS
by George Pierce

My first day in the Job Corps was pretty rough but I got it into my mind if John Doe could do it I could too. Today ten mistakes were made by some of the Corpsmen, They Quit! I asked them why they quit, so they said the Job Corps didn't have anything to offer them. I told them if they didn't put anything into it they wouldn't get anything out of it. But now is the time for all young men to put forth their best effort if they are ever going to meet the demands life put before them. To me the Corps is something that will give you a better chance in life. So far it taught me how to face things I never would hava know how to face. When things don't go my way, I get a little upset and want to go home, but I will stop and think, "Rome wasn't built in a day." Anything worth having is worth waiting for. Today most young people want to start at the very top but in order to get to the top, you must first start at the very bottom in order to reach the top. As a Negro, I know the hardship I must face so I think the Corps will help me to face them and learn a trade. I must learn it and be the best in it if I want to make a living plus being able to enjoy some of the riches in this world.

After I get out of the Corps I'm going to try and go to College and take up Social Work so I can help some of the boys from making the same mistakes I made. To me the Job Corps should be a necessity of life. I can remember the times my daddy would tell me all the things that I must face when I started out on my own. I thought he was talking and things couldn't happen in this modern age. The same thing is taking place today, the only differenca is it's 1965. I found out it is easy to say "I quit," but it takes a man to say "I will stay."

The young enrolees board an Air National Guard Constellation to depart for the flood area and to help with cleanup. The first plane ride for most.

STAFF ' JOB CORPS EXPRESS '

...or - Corpsman Robert Hussey
...ture - Corpsman Edward Vigil
...orters - Corpsmen Bob Sweatfield and George Pierce

...orts -
...artoonist - Rudy Mesa
...ypist - Mrs. Terry Pexa
...enter Staff Adviser - Geo. A. Wall

Continued from page 1

Reservoir holding 190,000 acre feet of water. This is not a large one at that. Two 18,000 Kilowatt generators feed electricity thru the transmission lines, taking power to parts of Nebraska, Colorado and Wyoming.

At this site it was evident the Corpsmen have their work cut out for them. They are carving roads and parking areas in a boulder patch situated on a sloping hill. It is just hard work. Soon the place will begin shaping up and then the Corpsmen shall see their labours bear fruit.

Fireplaces, shelter houses, trailer camps, tent locations, boat dock and ramps, picnic tables, toilets, and water wells are planned for future completion.

THE MEDICAL RUN

The Medical Run begins everyday starting at 8:30 in the morning and runs as long as there are Corpsmen waiting to the Doctor, Dentist or eye Doctor. These Doctors are all over town.

The Corpsmen are very well taken care of by all these doctors in Casper, and they appreciate the Nurses as much as the care the Doctor gives.

Most of the Corpsmen have to have eye care, dental work and some of them need medical care also.

The Corpsmen are glad to be able to go to the Doctor, Dentist, and Eye Doctor, and appreciate that they don't have to pay for this treatment, and care.

If any of the Corpsmen have to enter the hospital the Doctors take care of that too. So far we have had six Corpsmen hospitalized: Henry Kanaho, Rudolph Petersen, Jim Quinn, Billy Richardson, Jim Stallsworth and Mike Chavez.

The Casper Hospital, Memorial Hospital of Natrona County is one of the best in Wyoming.

PARENTS VISIT CASPER CENTER

Recently Mr. & Mrs. Baxter, parents of Corpsman Everett Baxter, were visitors at the Casper Job Corps Center. Mr. & Mrs. Baxter, residents of Denver, Colo. spent a few days visiting both Everett and the Center. Mr. & Mrs. Baxter were quite impressed with the Center, its operations and the success of their son in Work and Education programs.

Mr. & Mrs. Stallsworth, parents of Jim Stallsworth were in Casper recently, visiting Jim who is in the hospital recovering from an appendectomy. Jim was rushed to Natrona County Hospital on July 8th. He is expected home in a few days.

It goes without saying we here are very pleased to have these parents visit with us. A cordial welcome is extended to all parents to visit here at the Center.

CASPER JOB CORPS RECREATION

Corpsmen really had a 4th of July celebration with liberty on Saturday and Sunday, a big softball game Monday morning, with swimming at a public pool in the afternoon followed by a movie "Bells are Ringing."

The Corpsmen held a Hootenanny under Recreation Director Terry Pexa's direction. This was a real blast. More of these are to come.

July 7th and 8th found some Corpsmen going to the Shrine Circus. The movie "American in Paris" was viewed Friday evening.

Saturday turned out to be a real big day. A trio, the great "Cavucks" from Canada donated a couple of musicals hours. Such great singers as Corpsman Rudolph Petersen from Miami, singing "Frankie and Johnnie" and "It's Saturday Night and I just Got Paid." The great dancer Ken Pettyjohn did his horizontal dance variation nearly bringing down the rafters. Musically, things are looking up. It seems somebody pulled a F-44 and shot a piano into the Rec Hall.

ON THE SPORTS SIDE

We find our Recreation Director Terry Pexa working hard on a strong sports program.

On the softball scene there has been some heavy competition between dormitories. At the present Dorm A and C are tied for first place.

Dorm A has taken games from Dorms B, running over them 20-3 lead by the strong pitching of Billy Richardson and the hitting of Devon White and Nelson "Killer" Keller. The big "A" also ran Dorm E off the field 23-7. It appears that "A" is the leading contenders for the championship.

Dorm C in the race for 1st place. "C" dusted Dorm D by a narrow margin of 11-10. "C" lead by the pitching of John Brown. Brown being backed up by a strong in-field and many hard hitters.

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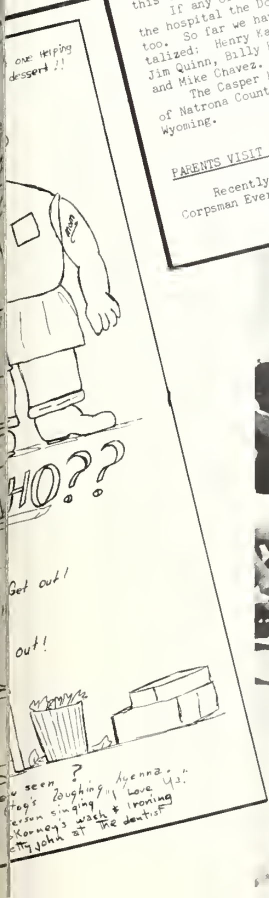


Congressman Wayne Aspinall of Colorado, and Kenneth Holum, Assistant Secretary of the Interior, visit with Corpsmen.

Corpsmen in the foreground, and the general public attend the dedication ceremonies of the Casper Center.

Photos by Stan Rasmussen and L. C. Axthelm

A woman reporter for the Lamar, Colo., newspaper, shoots a photograph of the arriving floodworkers.

Against a backdrop of mountains and greenery, Corpsmen of Collbran attended the outdoor dedication of their Center on June 19.

Most of their work also will be in such inviting scenery, but a change to the opposite within the week was due for some—and 30 volunteers were chosen. To take up shovels and buckets and clean up truckloads of muck and debris in the wake of a ruinous flood is not very pleasant work. However, after they spent 7 arduous days at the end of June doing it, Mayor R. E. Northrup of Lamar, wrote a letter saying:

"As you know, we detailed half of the boys to Holly and Granada as those two communities were flooded worse than Lamar and had smaller city organizations with which to start making a recovery.

"The Corps worked with our city crews at cleaning silt and debris off public property and city streets. They cleaned the basement of our city library and this was a big job.

"Also, through our chamber of commerce, they helped elderly and disabled people and I'm sure this was greatly appreciated.

"All in all, I consider the project a success and of material aid to our three Communities in Prowers County, and we thank you.

"As you know, the boys were housed in the Colorado National Guard Armory and were fed by guard personnel. We all owe this organization a great debt of gratitude."

The flood emergency required drastic and courageous adjustments for the youthful workers.

Courage and Stamina

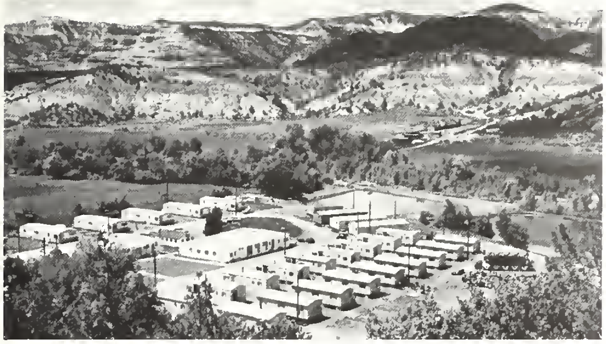
But that response was expected because it required courage and stamina for this heterogenous group of boys to make the adjustment from a life of deprivation and frustration to the positive role of Corpsmen.

"Homesickness dampens the enthusiasm of a few," said the Center Director, Murray Durst, "as does the barrage of inoculations." Few of them had experienced any contact with shots or planned medical care. Because of the required inoculations, seven dropped out of the program and went home. However, the episode of the shots and sore arms did a lot to weld together those who stayed.

At the Collbran Center, and in nearby areas, the work crews have accomplished several projects. They helped to prepare Vega Dam recreation area for summer visitors. They installed skirts around their dormitory houses, cleaned up construction debris, planted trees, and made other landscaping improvements.

Meals, abundant and varied, are one of the biggest attractions. Despite differences in geographical origin and eating habits, there has been no major problem in getting them to accept new foods.

Psychological and physical tests were made early, in the academic phase of the program. # # #



Ceremonies dedicating the scenic Collbran Center on June 19, are underway at lower right. The Center's buildings are convenient to the trout-stocked pond.

Appetizing food at Collbran is served by cooks Bob Oliver, Jo Wegner, and John Rodriquez.

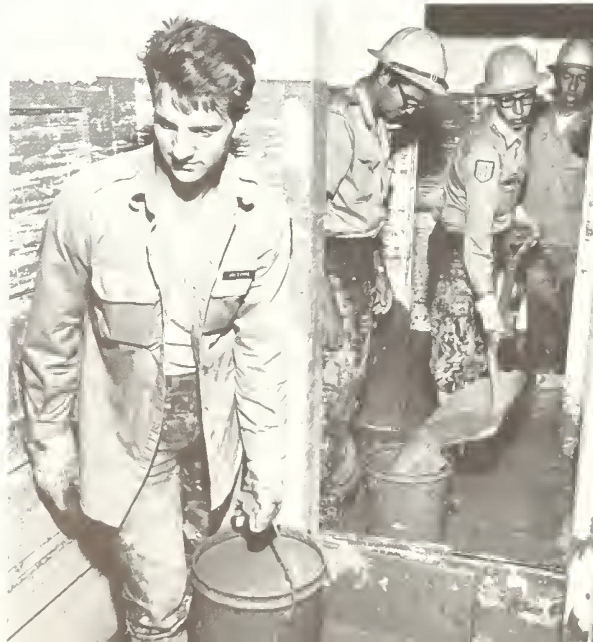
Making one's own bed is part of the Corpsman's daily routine.

Medic Michael Rodriguez is giving an inoculation to Jess Munoz. Looking on are Gary Horsman, J. C. Butler, Ray Shackelford, and Earl Poindexter.

The helpers taking part in this outfitting are from left, Jess Munoz and Ray Shackelford, enrollees, resident youth worker, Oliver Archuleta and supply clerk Jim Rooks.

On a landscaping project at the Center, Instructor Robert Emberty, right, and Medic Rodriguez, left, work with Garry Mull and Ron Dunn.

Part of the 30 Collbran men who did flood cleanup were these at work in the Lamar Library. They are, from left, Jim Evans of California, Robert Tallent of Texas, Tommy Martinez of New Mexico, and Jess Munz of California.



An estimated 12,000 fans turned out to view the first annual Bonneville Regata on August 14 and 15, and found that the large boulders on the rockface of the newly completed Willard Dam provided grandstand seating. Hydro speeds reached 170 miles per hour.

Hydroplanes Excite Crowd at Bureau's New Willard Reservoir

Thirteen of the world's largest racing boats—unlimited hydroplanes—thrilled big crowds at the Bureau of Reclamation's new Willard Reservoir near Ogden, Utah, on August 14 and 15. These large boats, which weigh from 3 to 5 tons each, skimmed over the choppy waters at speeds up to 170 miles per hour, and even with 180-degree turns averaged 105 miles per hour. The event, which was sponsored by the South Ogden and Brigham City Lions Clubs, was titled the "First Annual Lions Bonneville Regatta," and it drew crowds as large as 12,000. The hydroplane named "Miss Bardahl" won most of the races. The driver, Ron Musson, was presented trophies by Utah Governor Calvin L. Rampton.

Willard Reservoir is one of Utah's—indeed, one of Reclamation's—most unusual bodies of water. It is actually a broad arm of the Great Salt Lake that has been dammed by a 15-mile-long structure called Willard Dam. Spring floodwaters of the Weber River, which used to be lost in the Great Salt Lake, are now diverted into Willard Reservoir. Each year the water can be pumped back to the irrigation distribution systems for use on Weber Basin Project lands.

Although storage of water in Willard Reservoir began only a year ago, the unusually high runoff of 1965 almost filled the reservoir to capacity, which permitted the Bonneville Regatta to be held. Present plans call for making the regatta an annual event. # # #

Large cranes lifted the 3- to 5-ton hydros in and out of the water between each heat of the race so the crews could make the fine tuneup necessary for the speeds attained in this kind of regatta. In this photo, pit mechanics gas up the 25-foot-long "Notre Dame."

Retarding Evaporation in Small Reservoirs

by WILMON W. MEINKE and
WILLIAM J. WALDRIP, of the Texas Agricultural Experimental Station

Much has been written in recent years about the increasing water problem in the United States. Sources of water under the ground are no longer adequate to meet the needs of a growing population, so more and more surface water is used each year.

As a result of the increased use of surface water, there was a 71 percent increase in reservoir capacity between 1947 and 1954. And it has been estimated that the total reservoir capacity will double during the next 25 years.

For efficient use, millions of acres of rangeland depend on the proper amount and distribution of livestock water. Many range areas also rely primarily upon stock ponds for household water. Researchers have safely concluded that there would be many more potential water pond sites if the water could be maintained in shallow ponds, or on limited watersheds by a reduction of evaporation losses.

By far the biggest thief of water from ponds or small reservoirs is evaporation. As much water is lost each year to this surface water culprit as is consumed by all water users. On farm and ranch ponds in the Southwest, evaporation losses may be as much as 10 times the amount consumed by livestock. This loss in the 11 Western States averages 11.5 million acre-feet per year. The value of the loss ranges from a few cents to several dollars per thousand gallons. For example, costs for hauling livestock water in Throckmorton County, Tex., during the drouth of the 1950's averaged $6 per thousand gallons.

Expenditures of money on conservation by evaporation control measures should be based on the replacement costs of reservoir supplies from other sources, and on an estimated insufficient rainfall.

Funds for Research

Recognizing the need and possible opportunities for reducing the tremendous evaporation losses from farm and ranch ponds in Texas, the Water Commission for the State made research funds available to the Texas A. & M. Research Foundation in 1958. The resulting research was a joint effort by the Texas Agricultural and Engineering Experiment Stations. Field testing was carried out on the Texas Experimental Ranch in Throckmorton County.

Two copper mesh bags are used in this experiment to properly confine the chunks of solid emulsion evaporant.

In reservoir evaporation work, various ways have been recommended to reduce water losses. Two of the more practical methods are: the reduction of surface area by making the reservoir deeper and eliminating shallow areas; and the construction of windbreaks to reduce wind velocity.

A third method, however, which is the subject of this article, is the application of a chemical film on the reservoir surface.

Since farm or ranch ponds present problems not encountered with larger reservoirs, test conditions have been built. Twin ponds, each with a water surface 75 feet by 100 feet when filled to a depth of 5 feet, were constructed for tests at the Texas Experimental Ranch. A single large sheet of polyethylene was placed on the floor and sides of each pond to prevent seepage, and dikes were

constructed around the ponds to reduce runoff intake to a minimum.

One of the twins was treated with antievaporant and the other served as a check. A larger pond just above the twin ponds supplied water for the tests. Evaporation losses were computed by daily measurements of water levels in stilling wells.

The most commonly used evaporation control chemical is hexadecanol (or cetyl alcohol) a 16 carbon straight chain normal alcohol. When it is applied as a mono molecular film on the water's surface, evaporation may be reduced by 60 percent or more under favorable conditions. Hexadecanol is produced mostly from fats and oils, and it costs approximately 30 cents per pound.

There are alcohol mixtures which may be more effective than hexadecanol alone. For example, laboratory tests by the Texas Engineering Experiment Station indicated that a 50–50 mixture of hexa- and octa-alcohols gave better results. Also by adding other substances, better spreading and protection against bacterial decomposition is obtained.

Organism Life Unaffected

Hexa- and octa-decanol are odorless, tasteless, and nontoxic to plant and animal life. Although the material may change the biological balance in the water by serving as a food source for bacteria, observations of bacteria in the tanks on the Experimental Ranch showed no appreciable difference between the treated and untreated water.

Unlike large reservoirs, small ponds are not usually near sources of electric or mechanical power. But economic considerations dictate that film distribution systems be cheaply powered and easily maintained by nontechnical labor.

In addition, film movement by wind necessitates constant release from multiple points on the upwind shoreline. A chemical film travels approximately 3.4 feet for each 100 feet of surface wind travel. Based on this, approximately one-half pound of film chemical per day must be applied continuously to each 100 feet of upwind shoreline for each mile per hour of wind travel.

A number of systems, using both liquid and solid mixtures, were tested at College Station and on the twin ponds in Throckmorton County. A "controlled-environment chamber" designed and used by Dr. Morris E. Bloodworth, Head of the Department of Soil and Crop Sciences at Texas A. & M. University, provided an opportunity to study various aspects under fixed climatic conditions. The controlled environment chambers were extremely valuable in determining the effects of wind, temperature, and relative humidity upon evaporation. This phase of the study also provided a basis for calculating the cost of film chemical in saving a unit volume of water under a variety of climatic conditions.

Fourteen tests, ranging in length from a few days to more than 2 months, were conducted during the 5-year period on the twin ponds. The trials were based upon information derived from laboratory studies at College Station, and consisted basically of four systems of application: solid emulsions, solutions, liquid emulsions, and powder.

Solid Emulsions Tests

The initial field test series consisted of floating rods of solid emulsion attached to each other by heavy twine and placed on the water surface. Each rod was prepared by heating the hexaoctadecanol, emulsifier, soap, and mineral oil and pouring them into a given amount of water. The mixture was then poured into a mold forming a rod approximately 1 foot long. Within the mold, each emulsion rod solidified around a ½-inch-diameter polyethylene tube float. Although these rods worked satisfactorily under laboratory tests, no water was saved when they were tested in the field. Tests indicated no release of the film material from the rods, possibly because of the hard water at the field site. It is believed that calcium and magnesium in the water of the twin ponds sealed the rods in a film of insoluble soap.

Several more solid emulsions containing the fatty alcohols, emulsifiers, copper oleate, water and, in some cases, mineral oil were tested. Rather than forming rods, the solid was cut into 1-inch squares one-quarter inch thick, and the squares or chunks were placed in nylon-mesh bags. The mesh bags were later discarded for cylinders of ¼- or ⅛-inch hardware cloth equipped with plastic floats. Evaporation savings with the chunks of solid emulsion averaged approximately 19 percent of the evaporated total from the untreated pond, and the dispensing system was relatively trouble-free. Material cost, per thousand gallons of water saved from a 1-acre surface, was about 48 cents.

Solutions Tests

A 20-percent-by-weight solution of the film material in isopropanol was released through capillary drippers placed near the upwind shore. These drippers were attached to a 55-gallon supply drum through a constant head chamber by ½-inch polyethylene tubing.

Although the drippers were calibrated to deliver approximately 3 pounds of hexa-octadecanol per day, malfunction of the dripper units resulted in the dispensing of varying amounts averaging 1 pound per day.

Low temperatures (below 54° F.) caused crystallization in the feed lines and capillary dippers. Even with a return to higher temperatures, it was necessary to overhaul the distribution system in order to restore operation. Also, small foreign particles frequently lodged in the capillaries.

Despite the problems with material supply, the dripper method resulted in a water saving of 23 feet, or about 22.5 percent of the total evaporated, during a 70-day test period. For a 1-acre surface, material cost would have been approximately 83 cents per 1,000 gallons of water saved.

The same solution applied from constant-pressure dispenser cans suspended over the water resulted in similar savings. However, the individual can drippers were more trouble-free than the drippers attached to the supply drum by polyethylene tubing.

A 1-to-1 ratio of hexane with isopropanol prevented crystallization of the film material at temperatures above 32° F. However, at high temperatures the highly volatile hexane caused an increase in pressure in the can and a jetting of the material onto the water through drippers (or air vents).

Liquid Emulsions

A liquid emulsion containing approximately 10 percent hexa- and octa-decanol in water produced significant water savings when applied through a constant head emulsion dripper system similar to that described above. Clogging was not serious because of larger discharge jets. However, low temperatures and the difficulty in producing emulsions with constant-flow characteristics are disadvantages. Variable flow rates of different batches of emulsion require changes in calibration of the dripper system. Cost of materials only, based upon a 1-acre water surface, amounted to about 34 cents per thousand gallons of water saved.

This specialist is checking the operation of the dispenser can, which is the constant pressure type, another variety used in experimental retardation tests.

Powder Packages

A commercially prepackaged powder mixture of hexa- and octa-decanol was tested both at College Station and Throckmorton. The powdered material was supplied in 1- and 2-ounce quantities packaged in a water-soluble plastic bag. When placed in the water the bag dissolved and the freed fatty alcohol mixture which it contained dispersed to the water surface. Bags deposited on the upwind side of the experimental pond at Col-

lege Station dissolved and dispersed in 10 to 15 minutes; however, in this period of time the film and small agglomerates of powder were blown across the surface of the lake settling along the downwind shore.

In the test run on the twin ponds at Throckmorton, a package of chemical was placed into each of three copper screen wire baskets fixed in the water near the upwind shoreline. Evaporation savings during an 8-day test with this material totaled 20 percent, at a cost of only 17 cents per 1,000 gallons.

The concept of the soluble plastic package affords no advantage to an evaporation control program except a convenient means of storing and adding the chemical. The water saving potential arises from the fatty alcohols and not the soluble package. It is the opinion of some, who have tried the soluble package method, that the chemicals added by the soluble package weaken or make holes in the fatty alcohol film.

Results Compared

As a result of the four methods of film-chemical application about 20 percent water saving is possible. A comparison of the 20-percent water savings with the 40-to-50-percent savings obtained with these same preparations in small-tank laboratory studies (2.77 square feet of water surface) indicates that only 40 to 50 percent effective pond coverage was obtained by "upwind addition" of film chemical in the field tests. Variable prevailing winds in reference to the shoreline of application can create conditions of essentially 0 to 100 percent film cover.

This report on the use of the fatty alcohols, hexa- and octa-decanol, or the reported emulsion preparations (which contain cosmetic grade emulsifiers), does not imply an endorsement of the process by the Food and Drug Administration. However, the control pond, receiving these preparations at intervals over a period of 5 years, provided water for cattle use without apparent damage to them.

The small test pond, about one-sixth acre, used in this study gave costs ranging from $1.02 to $8.45 per 1,000 gallons of water saved. Eliminating the high costs experienced with the solvent-addition method, the range is from $1.02 to $2.45 per 1,000 gallons of water saved. Assuming that the same quantity of chemical would be adequate for a 1-acre pond (100 feet of shoreline normal to the prevailing wind by 435.6 feet long), the latter figures range from 17 to 43 cents per 1,000 gallons of water saved.

The figures for each 1-acre surface of the upwind dimension of the pond have been considered a standard for comparison. The longer the pond in a downwind direction for a given upwind shoreline, the greater will be the residence time of the film on the water, and therefore the greater will be the volume of water saved per weight of evaporation retardant added.

At the conclusion of 7 years of the tests, it is felt that a cost of $1 per 1,000 gallons of water saved is a realistic figure for the farm pond up to one-half acre. As pond size increases to 2 or 3 acres, the cost will vary from 50 cents to a minimum of 20 cents per 1,000 gallons of water saved.

# # #

FLOODS HIT COLORADO AND EASTERN SLOPE AREAS

In the middle of June and again in July, heavy rains in the Eastern slope areas of the Rocky Mountains caused one of the most disastrous floods of record in Colorado, some serious flooding in Kansas, and some in New Mexico.

Denver was the hardest hit city in the path of the uncontrolled waters that raged down the South Platte River Basin. Damages to all types of irrigation structures in the river basin, including the Cache la Poudre and the Big Thompson Rivers amounted to nearly $2¼ million. In the Arkansas River Basin including those at Fountain, Colorado, and along the Purgatoire River in the southwest, damages amounted to $1½ million.

The Bureau survey and estimate of damages was requested by the Office of Emergency Planning in cooperation with the State of Colorado. Reclamation engineers and specialists from several Region 7 offices were on practically around-the-clock duty surveying damages and estimating costs for repairs to diversion dams, dikes, canals, flumes, and other irrigation facilities. Preliminary investigations reports were promptly prepared and submitted to about 175 ditch companies.

Five-foot-deep floodwaters passed through this area on the Colorado-Big Thompson Project, Colo. Several emergency outages of electric power and widespread and costly damage resulted in several areas. One of the hazards was flood debris and trash, such as is shown here.

Also, assistance to applicants for funds and aid in the details of accomplishing emergency repairs were provided without delay.

As soon as floodwaters receded, repair work progressed so that crop loss would be minimized during the dry summer months. Emergency funds totaling about $4½ million were promptly made available for this work in 35 counties in Colorado and 21 counties in Kansas.

Three proposed dams, which have not been built because of local disagreements, would have captured floodwaters along the South Platte River greatly reducing damages, and would have stored the disastrous runoff for many beneficial uses. These are the Two Forks Dam to be below the confluence of North and South Forks of the South Platte; Chatfield Dam below the point where Plum Creek enters the river; and Narrows Dam about 7 miles upstream from Fort Morgan in northeastern Colorado.

Interest in building these control structures is now high (interest also has been high in some former years) as a result of this year's disaster.

Structures of the Bureau's Fryingpan-Arkansas Project, now underway, will store such high runoff as was along the Arkansas River.

Damage to Vermejo

In New Mexico, major Reclamation irrigation structures were undisturbed by the flood, but there was considerable damage to the Bureau's Eagle Tail Canal and the Diversion Canal on the Vermejo Project on the Vermejo River. Through rapid repair of the damaged works, all of these project lands were made ready for service of irrigation water.

Some communities in Colorado were subjected to electric power interruptions. It became apparent early in the morning of June 18, that floodwaters would reach the circuit breakers at the substation which serves electricity to the town of Fort Morgan. In this emergency, Bureau power specialists gave undaunted action and prompt service. Working in water, silt and muck, Reclamation personnel deenergized the substation, cleaned it up and bypassed the circuit breakers to prevent damage from short circuiting. Electric service was restored soon after 12 noon the same day.

A. P. Hall, city electrician for Fort Morgan said, "The Bureau personnel are to be highly commended for their valiant work cleaning up the substation by working in 4 to 5 feet of water so the substation might be energized and power restored to Fort Morgan."

The Bureau also promptly helped to restore electric service at other stricken facilities in Morgan and Washington Counties.

As floodwaters receded, the urgent need for cleanup manpower was eased by the arrival of Job Corpsmen from the new Bureau Centers at Casper, Wyo., and Collbran, Colo. The young men from Casper worked in and around Denver, and those from Collbran were flown to one of the hardest hit communities in eastern Colorado—Lamar. The service of these men was commendable in cleaning up both public and private properties. # # #

LAND DRAWING

Then and Now

Susan McGahey, who drew lucky names when she was 4 years old, is now making another drawing. But this time she is a coed. Board members seated at the table are, from left, Clinton Amo, secretary and Bureau representative; Melvin McInturf of Kennewick, Wash., member-at-large, and Ervin Easterday, of South Columbia Basin Irrigation District.

Sixteen years ago the first land drawing was held for lands to be irrigated on the Columbia Basin Project in central Washington State. Fifteen farm units were offered.

Preceding the first drawing, approximately 1,500 applications were received from more than half the States. For many it was a long-awaited day.

A representative from the Bureau of Reclamation, the South Irrigation District, and Melvin McInturf, an area landowner and veterans' representative, officiated. A comely 4-year-old girl—Susan McGahey—was selected to do the drawing.

Involved in the first event were 1,478 irrigated acres of farmland just northwest of Pasco that would be irrigated by relift pumping from the adjacent Columbia River. At that time work had only recently begun on the necessary waterways and works needed to deliver water to the projects prospective 1,029,000 irrigable acres, an area once referred to as fit for little but sagebrush and jackrabbits—providing the latter carried canteens.

Thirty-five land drawings later, in February 1965, another drawing was held, this time for 12 farm units north of Pasco. And now, close to half of the project is developed for irrigation farming, and last year's gross crop value was $64 million. Residents have had ample opportunity to judge the project's worth, and their response to the opportunity to secure a unit can be interpreted as their decision.

Residents Applied

For the 12 new available units in the newly developed irrigation block, 899 formal applications were received at the project office in Ephrata, an average of almost 75 applications per unit. More than half of these were from project area residents.

Besides the enthusiasm for the irrigated lands there was another pleasantly repetitious aspect to this drawing. This was the presence of the same Susan McGahey, now a coed at Eastern Washington State College in Cheney, again performing the drawing honors.

The drawing was held at the Pasco Elks Club. A luncheon just prior to the drawing was sponsored by the Pasco Chamber of Commerce. Chief speaker at the ceremonies was Gus Hokanson, Franklin County Extension Agent. The audience was estimated at 300, primarily farmers and local businessmen.

In his capacity as extension agent in the project area, Mr. Hokanson has worked closely with the lands and landowners of the southern project area and knows the agricultural problems and potentials of the area as well as anyone. This background made his remarks on the favorable economical aspects of irrigation farming, as contrasted to dryland operations, very meaningful to the audience. Apart from the statistics, perhaps the most significant statement to the listening prospective project farmers was: "most any crop can be grown on Columbia Basin Project lands . . . and as the project develops its farm units will become still more productive."

And it is just possible that the Pasco Chamber of Commerce is keeping Susan's name in their files for future drawings as the area's remaining potential irrigable land is developed. # # #

Long-Awaited Garrison Diversion Act Is Signed

President Lyndon B. Johnson is presenting a signing pen to Interior Secretary Stewart L. Udall as a memento of the authorization on August 5 of the Garrison Diversion Unit, MRBP. Assistant Commissioner G. G. Stamm, not shown in the photograph, also received a pen on behalf of Reclamation.
Others are from left, Representative Rolland Redlin (N. Dak.), Roy H. Holand, President of the Garrison Diversion Conservancy District; Representative Wayne N. Aspinall (Colo.), Clyde Ellis, General Manager of the National Rural Electric Cooperative Association; Oscar Berg representing a North Dakota water users association, Representative Leo W. O'Brien (N.Y.), Representative Mark Andrews (N. Dak.), Assistant Secretary Kenneth Holum, Senator Quentin N. Burdick (N. Dak.), Senator Milton R. Young (N. Dak.) who is hidden from view, Gordon Gray of the North Dakota Water Commission, Milo Hoisveen, State Engineer and Secretary of the North Dakota Water Commission; Senator Karl E. Mundt (S. Dak.), who is partly hidden; Senator George S. McGovern (S. Dak.), and William E. Welsh, Secretary-Manager of the National Reclamation Association.

Key Personnel Changed

Crandall Named Director; Clinton Retires

With the retirement of F. M. Clinton, long-term Reclamation employee, was the appointment of David L. Crandall of Burley, Idaho, as his successor as Director of Reclamation's Region 4, effective September 6.

Since 1960, Mr. Clinton has headed Region 4 with headquarters in Salt Lake City. He has completed over 30 years of Federal service, the last 28 of which have been continuously with the Bureau of Reclamation. Clinton also had been Director of Region 6 with headquarters at Billings, Mont.

Mr. Crandall has been with the Bureau since 1946 and moves to his new assignment from the position of Superintendent of the Minidoka Project in southern Idaho. A native of Idaho Falls, Crandall graduated from Stanford University as a civil engineer in 1941. He is a registered professional civil engineer and an associate member of the American Society of Civil Engineers. He comes from an illustrious water family as the son of the late Lynn Crandall who was District Geologist for the Geological Survey and Watermaster of the Upper Snake River for 30 years.

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award Date	Description of Work or Material	Contractor's Name and Address	Contract Amount
DC-6273	Seedskadee, Wyo	July 6	Repair of river outlet works stilling basin at Fontenelle Dam.	Saguaro Construction Co., Phoenix, Ariz.	$142,850
DS-6283	Central Valley, Calif	July 14	Two motor-voltage bus structures, two 600-volt station-service feeder busways, and two 1,500/1,725-kva power transformers for Mile 18 pumping plant. Schedule 1.	I-T-E Circuit Breaker Co., Philadelphia, Pa.	325,949
DS-6283	do	July 6	Six switchgear assemblies for Mile 18 pumping plant, Schedule 2.	Westinghouse Electric Corp., Denver, Colo.	175,820
DS-6284	Office of Economic Opportunity, N.Y.	Sept. 3	Furnishing and erecting dormitory complexes, office and dispensary complex, and education, messing and recreation complex for Iroquois Job Corps conservation center, Schedule 3. (Negotiated Contract.)	Benderson Development Co., Inc., and Admiral Homes, Inc., Buffalo, N.Y.	309,300
DS-6284	Office of Economic Opportunity, Minn.	July 19	Furnishing and erecting dormitory complexes, office and dispensary complex, education complex, and messing and recreation complex for Tamarac Job Corps conservation center, Schedule 5.	Frontier Homes Corp., Omaha, Nebr.	484,545
DS-6286	Missouri River Basin, Kans.	July 16	Twelve 50-foot by 21.76-foot radial gates for spillway at Glen Elder Dam.	Johnson Machine Works, Inc., Chariton, Iowa.	299,055
DS-6287	Pacific Northwest-Pacific Southwest Intertie, Nev.	July 27	Twenty-two 230-kv power circuit breakers for Mead substation, Schedules 1 and 2.	General Electric Co., Denver, Colo.	1,486,590
DS-6287	do	do	Two 230-kv power circuit breakers for Mead substation, Schedule 3.	Cogenel, Inc., New York, N.Y.	148,703
DS-6291	Atmospheric Water Resources Program, Park Range, Colo.	July 15	Application of weather modification techiques to mositure-transporting air masses east of Steamboat Springs, Colo. (Negotiated Contract.)	E. Bollay Associates, Inc., Boulder, Colo.	672,100
DC-6294	Emery County, Utah	July 27	Construction of 5 miles of Huntington North service and North reservoir feeder canals, and construction of a 3,600-foot earth dike.	E. V. Chettle, Salt Lake City, Utah.	274,566
DC-6295	Colorado River Storage, Colo.	Aug. 2	Construction of 115-kv additions to Salida substation.	Sturgeon Electric Co., Denver, Colo.	128,974
DS-6296	do	Aug. 13	Supervisory control and digital telemetering with automatic data logging equipment for Montrose power operations center and Blue Mesa powerplant.	Gulton Industries, Inc., Schiller Park, Ill.	106,161
DC-6299	San Juan-Chama, N. Mex.	July 22	Construction of El Vado Dam outlet works	Peter Kiewit Sons' Co., Omaha, Nebr.	1,633,153
DC-6304	Missouri River Basin, Nebr.	July 27	Construction of stage 02 additions to Sidney substation.	Lindstrom Construction Co., Grand Forks, N. Dak.	143,000
DS-6305	Office of Economic Opportunity, Ohio.	July 22	Furnishing and erecting dormitory complexes, office and dispensary complex, and education, messing, and recreation complex for Ottawa Job Corps Conservation Center, Schedule 1.	De Rose Industries, Inc., Bonham, Tex.	330,645
DS-6305	do	July 21	Furnishing and erecting dormotiry complexes, office and dispensary complex, education complex, and messing and recreation complex for Weber Basin Job Corps Conservation Center, Schedule 2.	Utah Mobile Homes, Salt Lake City, Utah.	461,293
DC-6310	Missouri River Basin, Nebr.	Aug. 5	Construction of 15 miles of Farwell Main laterals M-6.3 to M-9.1 and Farwell Central laterals C-0.6 to C-6.3, Section 3.	Bushman Construction Co., St. Jospeh, Mo.	312,599
DS-6311	Central Valley, Calif	Aug. 10	Three 230-kv power circuit breakers for Mile 18 switchyard.	Westinghouse Electric Corp., Denver, Colo.	192,169
DC-6314	Silt, Colo	Sept. 29	Construction of Silt pumping plant and appurtenant works, utilizing steel pipe for discharge line, Schedule 2.	Varulco, Grand Junction, Colo.	597,170
DC-6315	Gardena Farms Irrigation District No. 13, Wash.	Aug. 10	Construction of Burlingame Diversion Dam	Federal Construction Co., Spokane, Wash.	142,025
DC-6316	Missouri River Basin, Kans.	Aug. 23	Construction of Almena Diversion Dam	Bushman Construction Co., St. Joseph, Mo.	549,650
DC-6317	Colorado River Storage, Ariz.	Aug. 6	Completion of left diversion tunnel plug and spillway elbow at Glen Canyon Dam.	S. S. Mullen, Inc., Seattle, Wash.	1,535,333
DC-6319	Missouri River Basin, Nebr.-Wyo.	Sept. 7	Construction of the 73-mile Glenrock-Stegall 230-kv transmission line, second section.	Lindberg Construction Co., Jamestown, N. Dak.	2,367,352
DC-6320	Blackfeet Indian Irrigation, Mont.	Sept. 2	Construction of Lower Two Medicine Dam	Sletten Construction Co., Great Falls, Mont.	1,282,498
DC-6322	Missouri River Basin, S. Dak.	Sept. 22	Construction of stage 07 additions to Sioux Falls substation.	C. L. Electric Co., Pocatello, Idaho.	718,598
DS-6323	Missouri River Basin, Kans.	Aug. 30	Twelve 75,000-pound radial-gate hoists and 12 gate position indicators for spillway at Glen Elder Dam.	McGee and Hogan Machine Works, Salt Lake City, Utah.	169,115
DC-6325	Arbuckle, Okla	Aug. 27	Construction of 18 miles of pipelines for Wynnewood aqueduct and Wynnewood pumping plant.	Amis Construction Co., Oklahoma City, Okla.	1,627,000
DC-6328	Office of Emergency Planning, Colo.	July 10 (Saturday)	Repair of Model-John Flood Diversion Dam and Antonio Lopez Diversion Dam on the Purgatoire River near Trinidad, Colo. (Negotiated Contract.)	Sharpe Construction Co., Trinidad, Colo.	123,380
DC-6334	Canadian River, Tex	Sept. 27	Construction of chlorination stations for Main aqueduct at pumping plant No. 1 and Sta. 1884+50 and 5080+10 sites.	Brown-McKee, Inc., Lubbock, Tex.	142,211
DC-6349	Seedskadee, Wyo	Sept. 24	Foundation grouting at Fontenelle Dam. (Nehotiated Contract.)	Boyles Bros. Drilling Co., Salt Lake City, Utah.	728,330
200C-600	Central Valley, Calif	July 9	Collection and disposal of debris within Clair Engle Lake.	Sanders Construction Co., Shasta, Calif.	184,600
200C-601	do	July 21	Rehabilitation of the fish ladder and adjacent area at Nimbus Fish Hatchery.	Judson Pacific-Murphy Corp., Oakland, Calif.	384,682
200C-606	do	Sept. 8	Rehabilitation of 10 timber bridges on Delta-Mendota Canal between Mile 70.01 and 90.54.	Kaweah Construction Co., Visalia, Calif.	147,853
300C-233	Colorado River Front Work and Levece System, Ariz.	Aug. 19	Construction of levee and bank protection of the Colorado River.	Karl A. Dennis, d.b.a. Dennis Construction Co., Yuma, Ariz.	155,410
400C-305	Silt, Colo	Sept. 7	Construction of 2 miles of Dry Elk Valley lateral and rehabilitation of 1 mile of Grass Valley Canal.	Lee Johnson Construction, Rifle, Colo.	134,221
400C-306	Weber Basin, Utah	Sept. 24	Repair of Gateway Canal, sta. 188+50 to 441+50	Weyher Construction Co., Salt Lake City, Utah.	147,920

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MAJOR RECENT CONTRACT AWARDS—Continued

Spec. No.	Project	Award Date	Description of Work or Material	Contractor's Name and Address	Contract Amount
500C-207	Arbuckle, Okla	Aug. 13	Construction of boat launching ramps, road and parking areas for recreation facilities for Arbuckle Reservoir.	Amis Construction Co., Oklahoma City, Okla.	159,000
500C-209	Canadian River, Tex	Sept. 14	Construction of roads, parking areas, and boat ramp for public use facilities for Plum Creek, Sanford, Reservoir.	TCO, Inc., White Deer, Tex	127,166

Major Construction and Materials for Which Bids Will Be Requested Through November 1965*

Project	Description of work or material
Baker, Oreg	Constructing Mason Dam, an earth and rock fill structure about 170 ft high, 890 ft long, containing about 900,000 cu yd of materials, and appurtenant features. The spillway will consist of an ogee crest and open chute in the left abutment and a stilling basin.
Do	Clearing about 2,500 acres in Mason Ressrvoir site. About 18 miles southeast of Baker.
CVP, Calif	Constructing about 23 miles of 8- to 30-in.-diameter Colusa County, Unit 1B pipelines for heads varying from 25 to 150 ft. Near Arbuckle.
Do	Constructing 13 floatwells at various locations along the canal and installing electrical cable and controls between the floatwells and check structures. Near Corning on the Corning Canal.
Do	Twelve 230-kv, 1,200-amp air switches for Mile 18 switchyard.
Do	Constructing about 64 miles of 8- to 84-in.-diameter pipelines for heads varying from 25 to 175 ft. Westlands Pipelines, Laterals 1-3, near Fresno.
Do	Constructing fish facilities in the Tehama-Colusa Canal immediately downstream from the Red Bluff Diversion Dam. Work will consist of constructing a reinforced concrete louvered fish structure, a settling basin with bottom width of 260 ft and about 2,000 ft long, and a reinforced concrete check velocity barrier structure with three 14- by 10-ft radial gates. Near Red Bluff.
Colo. River Front Work and Levee System, Calif.	Constructing access roads, quarrying rock, clearing and shaping banks, constructing training structures, and placing rock in structures for bank protection on the California and Arizona sides of the Colorado River.
Do	Hauling and placing riprap on bank protection structures, and constructing gravel access and service roads. Along the Colorado River, about 4 miles south of Palo Verde.
CRSP, Colo	Constructing about 87 miles of single-circuit, 3-phase, 230-kv Poncha-Midway Transmission Line. Extending from Salida to vicinity of Midway.
Fryingpan-Arkansas, Colo.	Constructing 7.7 miles of relocated county road including earthwork, culverts, and surfacing. Around Ruedi Reservoir, about 20 miles east of Basalt.
MRBP, Iowa	Two 3-phase, 14,000-kva, 154/115/69/13.8-kv mobile power auto transformers, or as alternate, three single-phase, 10,000-kva, 154/115/69/13.8-kv mobile power autotransformers.
MRBP, Kans	Constructing the Downs Dike, Section 2, an earthfill structure about 40 ft high, 15,000 ft long, containing about 2,400,000 cu yd of materials, an outlet works, and a drain system. Near Downs.
MRBP, Mont	Constructing the Yellowtail Dam Visitor Center will consist of constructing a one-story reinforced concrete masonry and precast Mo-Sai panel building of about 4,600 sq ft on the main floor and about 1,600 sq ft in the basement. Southeast of Hardin.
Pacific Northwest-Pacific Southwest Intertie, Ariz.	One 230-kv, 20,000-mva, 1,600-amp power circuit breaker for Liberty Substation.
Pacific Northwest-Pacific Southwest Intertie, Nev.-Ariz.	Constructing about 240 miles of single-circuit, 3-phase, 345-kv Mead-Liberty Transmission Line. Extending from vicinity of Boulder City, Nev., to a point near Liberty, Ariz.
Pacific Northwest-Pacific Southwest Intertie, Calif.	Constructing about 34 miles of single-circuit, 3-phase, 230-kv Round Mountain-Cottonwood Transmission Line. Work will consist of clearing right-of-way; constructing footings; furnishing and erecting steel towers; and furnishing and stringing three 795 MCM, ACSR conductors. Extending from vicinity of Round Mountain to vicinity of Cottonwood, Calif.
Pacific Northwest-Pacific Southwest Intertie, Nev.	Constructing about 145 miles of single-circuit, 2-pole, 750-kv, d-c Beatty-Mead Transmission Line. Work will consist of clearing right-of-way; constructing footings; furnishing and erecting steel towers; and furnishing and stringing two 2,300 MCM, ACSR conductors per pole, and one 0.486-in.-diameter alumoweld strand overhead ground wire.
Do	Fifty-three 230-kv and one 345-kv disconnecting switches for Mead Substation.
Do	Rebuilding or replacing two 230-kv, 1,600-amp, 10,000-mva power circuit breakers for Mead Substation.
San Juan-Chama, New Mex.	Constructing the 5-mile-long, concrete-lined Oso Tunnel of either 8-ft 7-in. diameter circular section or 8-ft 3-in. diameter horseshoe section; constructing two 96-in.-diameter siphons totaling about 1,200 ft in length of either precast concrete pressure pipe or monolithic concrete. Southeast of Pagosa Springs, Colo.
Weber Basin, Utah	Cleaning, reshaping canal prism, and repairing compacted earth lining in about 12,000 ft of canal with finished canal prism. Ogden Valley Canal, near Ogden.

*Subject to change.

In its assigned function as the Nation's principal nature resource agency, the Department of the Interior bears a special obligation to assure that our expendable resources are conserved, that renewable resources are managed to produce optimum yields, and that all resources contribute their full measure to the progress, prosperity, and security of America, now and in the future.

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